QUARTERLY REPORT NO. 3

(FOR PERIOD ENDING MAY 31, 1975)

ENVIRONMENTAL BASELINE DATA COLLECTION
AND
MONITORING PROGRAM

FEDERAL PROTOTYPE OIL SHALE LEASING PROGRAM

TRACTS U-a and U-b

UTAH

WHITE RIVER SHALE PROJECT

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I. INTRODUCTION

This document is a summary of work conducted as part of the environmental baseline monitoring program for the period of March 1, 1975, to May 30, 1975. The baseline program was conducted in accordance with the "Partial Exploration Plan, Environmental Baseline Data Collection and Monitoring Element," submitted July 1, 1974; and the Conditions of Approval developed by the Area Oil Shale Supervisor (AOSS) for various sub-elements of the program. As requested by the AOSS, the field data collected for this quarterly period have also been submitted and are on file in the AOSS office in Grand Junction, Colorado. This summary report presents an overview of these data and has been organized and correlated with prior quarterly reports.

Summary data presented within this report represent quantitative analyses of data compiled from the beginning of the program to the present for the water and air resources programs. Surface water discharge and quality records from October 1974 to the present have been compiled and are presented in graphic form along with ground water elevations compiled from December 1974 to the present. Air resources data have been correlated with comparable information from previous quarters and where possible, from previous years. Results are also shown of laboratory analyses of tract metals and radioactivity in all samples collected during the baseline program.

The Fish and Wildlife Management Plan for the exploratory phase was presented to the Oil Shale Environmental Advisory Panel (OSEAP) and the Area Oil Shale Office (AOSO) May 23, 1975, and accepted as meeting the requirements of Section 4 (A) of the Oil Shale Lease Environmental Stipulations. Copies of the plan were issued to all panel members; consequently, the plan is not included within this quarterly report.

II. WATER RESOURCES

A. WORK COMPLETED

1. SURFACE WATER

During the third quarter, regional surface flow regime was defined and site specific surface hydrologic-related data were synthesized. Sufficient regional and site specific surface hydrologic data are now available for preliminary evaluation.

2. SURFACE WATER QUALITY

Surface water sampling is progressing as scheduled. The results are being statistically analyzed. Preliminary statistical evaluation of water quality was conducted to determine whether sampling frequency and total constituent analyses could be reduced. Data analysis suggests an excess of data is being collected for defining the water quality setting; recommended modifications in the surface water program will be submitted to the Area Oil Shale Supervisor (AOSS) for approval.

3. GROUND WATER

During April and May 1975, a regional hydrogeologic report was prepared from literature review and geophysical logs of selected wells within 5 miles of the tracts. The logs indicated that the principal tract aquifer extends outward at least 5 miles to the north, west, and south of the tracts.

Along the eastern boundary of the tracts the aquifer is exposed in Evacuation Creek canyon. May 5 through 10, 1975, VTN hydrogeologists conducted a detailed investigation of the stream-aquifer interrelationship along a 10-mile segment of Evacuation Creek, starting from the White River. The summary report of this survey is presented in Section II.B.3.

4. GROUND WATER LEVEL MONITORING

The water level monitoring program is divided into two phases--monthly measuring with a probe and continuous monitoring with pressure transducers and electric punch clocks. Some problems occurred with the X-holes because they are open to their total depth and tar has accumulated on the water surface, making accurate measurement nearly impossible. Because of the high humidity in these holes, the electric probe is frequently triggered far above the true water surface, and chalk is washed from the steel measuring tape before it can penetrate to the water surface.

The continuous monitoring program is being conducted at Wells P-1, P-2 upper, P-2 lower, and P-3. Two problems occurred in the continuous monitoring program. The 5 psi (scaled to 10 feet) transducers accumulated water in the inner workings and caused them to malfunction; water levels rose above the 5 feet maximum recording range, invalidating the resulting data. They were replaced by 50 psi (scaled to 100 feet) units that have the added advantage of being small enough to fit in the 2-inch monitoring tubes at the aquifer test sites and need not be removed from the large-diameter pumping wells during pumped quality sampling.

5. GROUND WATER QUALITY

During March, pumped ground water samples were collected from every suitable bedrock aquifer well being studied. Additional samples were collected from selected wells in April and May. The lab results of samples submitted in April and May are not yet available.

B. DATA SUMMARY

1. SURFACE WATER

The USGS has been collecting regional and historic flow data for 50 years on the White River, near Watson. This and 13 additional gaging stations installed for the baseline monitoring program measure stream flow in and around the tract areas. Gaging stations S-1, S-3, S-4, and S-11 measure stream flow on the White River; S-2, S-6, S-7, S-8, and S-15, on Evacuation Creek; S-9 and S-13, on Southham Canyon; S-10 and S-12, on Asphalt Wash; and S-5, on Hells Hole Canyon. Stations S-1, S-2, S-3, S-4, S-6, and S-11 measure perennial stream flow; S-5, S-7, S-8, S-9, S-10, S-12, S-13, and S-15 are located on ephemeral streams which typically flow only during snowmelt or rainstorm periods. The stream gaging network was planned to measure flows resulting from normal climatic events and unusually high flows from intense thunderstorms.

Historic and 1974 S-3 gaging records were compared to determine whether the current year is unusual. This comparison shows that flows during October and November 1974 were close to the historic mean monthly flow; December through April flows were only 78 percent of normal. Flows for the White River average 355 cfs from December through February with an average flow of 511 cfs for March.

Relations between stream flow records, specific conductance, and temperature (Table II-1) for S-1, S-4, and S-11 were evaluated to determine if stream flow or quality changed between these stations. It was determined that the average correlation coefficients for the three possible station parings are .99 for flow, .98 for specific conductance, and .99 for temperature. The high correlation between the White River stations indicates redundant data. Similarly, the five Evacuation Creek gages are monitoring stream flow that could be effectively monitored by S-6 and S-2 and still follow the guidelines in the Conditions of Approval.

Flow, temperature, and specific conductance were compared for Evacuation Creek gaging stations S-2, S-6, and S-7. The average correlation coefficients for the three possible station parings were .91 for flow, .96 for temperature, and .90 for specific conductance. Evacuation Creek dry wash gaging stations S-8 and S-15 have not monitored stream flow as of June 1, 1975. Based on current records, removal of S-7, S-8, and S-15 from the program would not affect the credibility of the final report.

Two meteorological parameters, precipitation and evaporation, are being monitored as part of the water resources program. The records from the 20 on-tract precipitation gages (Table II-2) are remarkably consistent (Table II-2) when elevation and slope are considered in the analysis. Based on preliminary data, it appears that 14 stations could be removed without significantly

TABLE II-1

1974/75 Conductance, Temperature and Streamflow Analysis

PARAMETERS	STA	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	STATUS OF STREAM
Cond (Microhms)	S-1	762	791	891	859	845	916	902						Perennial
Temperature (°C)		11.5	3.5	1.0	.5	1.0	2.0	8.5						
Discharge (cfs)		432	404	300	343	381	502	461						
Conductivity	S-2	4550	4660	4920	4730	4730	3660	-						Perennial
Temperature		11.0	4.5	.5	.5	3.0	4.0	7.0						
Discharge		-	-	-	-	-	.72	-						
Conductivity	S-3	763	811	904	859	853	906							Perennial
Temperature		11.5	3.5	0	.5	0	1.5	8.5						
Discharge		432	437	298	343	381	511	473						
Conductivity	S-4	761	799	880	873	-	-	-						Perennial
Temperature		11.5	3.5	.5	0	0	2.0	-						
Discharge		430	443	305	343	381	506	441						
Conductivity	S-5					272	291							Dry Wash
Temperature						3.0	2.7							
Discharge						323(1	388(1							
Conductivity	S-6	5410	5370	6260	5880	5940	3660	-						Perennial
Temperature		10.5	4.5	1.5	1.0	1.0	3.0	6.0						
Discharge			.04	.17	.1	-	1.2	-						
Conductivity	S-7	4500	4540	5140	5640	4540	3750	-						
Temperature		11	3.5	0	.5	2.0	3.5	6.4						
Discharge		-	-	-	-	-	-	1.3						
Conductivity	S-8							No record to date						Dry Wash
Temperature														
Discharge														
Conductivity	S-9					135								Dry Wash
Temperature						0								
Discharge						151(1								
Conductivity	S-10					-								Dry Wash
Temperature						.5(1								
Discharge						149								
Conductivity	S-11	763	805	910	863	848	927							Perennial
Temperature		11.5	.5	.5	.5	.5	2.0							
Discharge		440	437	301	343	381	516							
Conductivity	S-12					135	-							Dry Wash
Temperature						4.5	4.5							
Discharge						-	148(1							
Conductivity	S-13					-	-							Dry Wash
Temperature						0.0(1	-							
Discharge						250(1	222							
Conductivity	S-15							No. Record To Date						Dry Wash
Temperature														
Discharge														

(1 Single Flow Events

affecting the reliability of the meteorology program. Stations S-1, S-3, S-8, P-1, A-2, and A-8 should be used as the prime sites for monitoring rainfall and should provide the necessary information to adequately monitoring climatic conditions for the tracts. S-1 will effectively monitor rainfall, now being monitored for S-2 (correlation coefficient .87); S-3 will effectively monitor rainfall for A-12, S-4, S-11, S-13 (cc .98); S-8 will effectively gage rainfall for S-6, S-7, and S-15 (cc .97); A-8 will monitor and allow additional correlation with S-6, S-7, and S-15. Similarly, A-2 will gage rainfall for A-4 S-10, and S-12 (cc .93).

The average rainfall during the study period was 7.91 inches. The monthly high in May was 2.6 inches and the monthly low in December was 0.18 inches. Evaporation rates for May and June totaled 7.84 inches (Table II-2). Evaporation rates for October through April will be determined from the air quality monitoring program and will be summarized when data reduction is completed.

2. SURFACE WATER QUALITY

Data from the water quality monitoring program (Table II-3) indicates that the number of samples and tested parameters appear excessive. Complete statistical evaluation and data correlation of water quality will be presented in the next quarterly report. The only parameters which have been varying to any degree are Ca, Mg, HCO_3, Na, Al and SO_4. Figures II-1 through II-6 illustrate stream flow water quality characteristics for the White River and Evacuation Creek. Figures II-1 through II-3 summarize conductivity, sediment, and water quality parameters for Station S-3.

TABLE II-2
Summary of Precipitation and Evaporation Analysis

Precipitation Station	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APRIL	MAY	JUNE	JULY	AUG.	SEPT.
Average	1.04"	.24"	.18"	.92"	.31"	1.08"	1.6"	2.6"				
RS-1	.89	.23	.12	1.04	.34	1.14	.96	2.85				
RS-2	.97	.06	.16	1.01	.30	1.23	1.73	2.06				
RS-3	.91	.18	.16	1.12	.24	.87	1.49	2.64				
RS-4	1.04	.27	.10	.80	.22	.87	1.65	2.81				
RS-P1	1.02	.27	.11	.94	.23	.90	1.55	2.85				
RS-6	.95	.43	.18	.97	.34	1.06	1.42	3.05				
RS-7	1.48	.15	.34	1.0	.37	1.18	1.36	2.94				
RS-8	1.04	.36	.29	1.33	.33	1.16	1.41	2.67				
RS-9	.97	.33	.16	1.00	.34	1.40	1.92	2.60				
RS-10	.99	.28	.13	1.00	.28	1.45	1.72	2.03				
RS-11	.93	.22	.14	1.10	.24	1.13	1.61	2.20				
RS-12	.99	.28	.15	1.10	.28	1.30	1.71	2.31				
RS-13	.90	.17	.10	1.04	.25	1.03	1.60	2.26				
RS-15	1.53	.18	.38	1.07	.37	.93	1.40	2.93				
Auto - P1				.70	.30	.80	1.70	2.90				
Auto - ARS-12				.60	NR	1.10	1.80	2.50				
Auto - ARS-4				.87	.40	1.00	1.90	2.70				
ARA-2				.50	.30	1.00	1.75					
ARA-4				.80	.50	1.30	2.00	2.60				
ARA-8				.50	.40	.90	1.70	2.50				
EA A-6 Evacuation Ridge - Evaporation							5.2	2.64				
EA 2 West Southam - Evaporation							5.2					

TABLE II-3

WATER QUALITY SUMMARY
OIL SHALE TRACTS Ua-Ub

Semi-Monthly Samples

Parameters Station		S1 6400	S2 6430	S3 6500	S4 6600	S5 6405	S6 0420	S7 6415	S8 6425	S9 6605	S10 6620	S11 6700	S12 6625	S13 6610	S1 6417
Speci-fic Cond	High	927	5500	1020	1100	(3 No Data	6170	(3 11500	(3 No Data	(3 No Data	(3 No Data	1650	(3 No Data	(3 No Data	(3 No Data
	Low	770	2800	630	700		3500	3400				650			
	Ave	829	4212	990	849		5380	3990				891			
COD 4	High	32	88	38	36	No Data	110	33	No Data	No Data	No Data	33	No Data	No Data	No Data
	Low	0	6	2	3		34	20				4			
	Ave	9.7	29.5	10.13	15.3		50	24.4				12.6			
pH	High	10.5	8.7	10.3	10.6	No Data	9.0	9.4	No Data	No Data	No Data	11.2	No Data	No Data	No Data
	Low	6.0	6.0	7.0	6.0		6.5	8.1				6.1			
	Ave	8.34	7.2	8.5	8.16		7.85	8.6				8.35			
CO_2 4	High	389(1	864(1	246(1	389(1	No Data	298(1	5.9	No Data	No Data	No Data	311(1	No Data	No Data	No Data
	Low	0	1.6	1.1	0		.9	.3				0			
	Ave	2.84	5.8	5.48	4.99		47	3.36				4.61			
Alka-li-nity 4	High	228	444	236	242	No Data	527	469	No Data	No Data	No Data	227	No Data	No Data	No Data
	Low	185	247	184	181		297	360				183			
	Ave	201	397	213	205		446	406				203			
HCO_3 4	High	266	541	288	295	No Data	642	572	No Data	No Data	No Data	280	No Data	No Data	No Data
	Low	193	301	224	221		444	439				223			
	Ave	241	482	271	249		544	406				247			
CO_3 4	High	22			7	No Data			No Data	No Data	No Data	5	No Data	No Data	No Data
	Low	0	0	0	0		0	0				0			
	Ave	1.47			.44							.33			
Oil and Grs. 4	High	11	250	6	180	No Data	8	11	No Data	No Data	No Data	7	No Data	No Data	No Data
	Low	0	0	0	0		0	0				0			
	Ave	2.8	23	2.57	18		2.3	2.4				2.93			
Disvd. NH_3 4	High	.29	.12	.12	.12	No Data	.10	.11	No Data	No Data	No Data	.15	No Data	No Data	No Data
	Low	.01	.01	.01	.01		.02	.02				.01			
	Ave	.062	.05	.06	.05		.05	.05				.06			
NO_3 4	High	.01	1.5	.01	.04	No Data	.03	.04	No Data	No Data	No Data	.02	No Data	No Data	No Data
	Low	0	0	.0	.0		0	.01				0			
	Ave	.001	.34	.003	.01		.01	.03				.004			
K-N 4	High	1.2	1.2	.94	1.2	No Data	1.5	1.3	No Data	No Data	No Data	.90	No Data	No Data	No Data
	Low	.03	.36	.10	.03		.63	.59				.07			
	Ave	.46	.67	.36	.44		.92	.79				.37			
NO_2 4	High	.51	1.5	.40	1.1	No Data	2.2	8.8	No Data	No Data	No Data	.54	No Data	No Data	No Data
	Low	0	0	.01	0		0	.03				0			
	Ave	.148	.33	.26	.21		.68	5.63				.14			

(1 Anomalous reading
(2 µg/1 Micrograms per liter
(3 Dry Wash Station
(4 mg/1 - milligram per liter
S Picocurries

TABLE II-3 (CONTINUED)
WATER QUALITY SUMMARY
Ua-Ub Oil Shale Monitoring

Semi Monthly Samples

Parameters Station	S1 6400	S2 6430	S3 6500	S4 6600	S5 6405	S6 0420	S7 6415	S8 6425	S9 6605	S10 6620	S11 6700	S12 6625	S13 6610	S15 6417
(4 Disvd.High Ortho.Low Phste.Ave	.12 0 .05	.09 0 .03	.15 0 .06	.15 0 .05	No Data	.09 0 .04	.09 .03 5.4	No Data	No Data	No Data	.09 0 .04	No Data	No Data	No Data
Total High(4 Phos- Low phous Ave	.47 .01 .09	.30 .01 .05	.74 0 .17	.48 .02 .16	No Data	3.3 .01 .45	.16 .01 .04	No Data	No Data	No Data	.20 0 .08	No Data	No Data	No Data
Disvd.High(4 Ortho.Low PhsphsAve	.04 0 .17	.03 0 .01	.05 0.0 .02	.04 .0 .02	No Data	.03 .0 .01	.03 .01 .02	No Data	No Data	No Data	.03 0 .02	No Data	No Data	No Data
S High(4 Low Ave	2.5 .0 .27	.3 0 .08	.2 .0 .09	1.3 0 .18	No Data	.3 0 .11	2.3 0 .5	No Data	No Data	No Data	1.3 0 .15	No Data	No Data	No Data
High(4 Hard- Low ness Ave	320 260 288	1200 690 1092	460 240 299	340 260 295	No Data	1600 840 1321	1300 980 1116	No Data	No Data	No Data	320 270 297	No Data	No Data	No Data
Non High(4 carb. Low Hdns. Ave	120 71 85	770 440 684	260 77 95	120 68 89	No Data	1100 540 871	820 620 708	No Data	No Data	No Data	120 65 92	No Data	No Data	No Data
Ca High(4 Low Ave	83 61 70	200 140 168	120 60 76	83 62 71	No Data	240 160 200	200 160 172	No Data	No Data	No Data	83 61 72	No Data	No Data	No Data
Mg High(4 Low Ave	30 23 26.9	170 100 159	34 24 28	36 23 28	No Data	250 130 198	190 140 166	No Data	No Data	No Data	36 24 28	No Data	No Data	No Data
Na High(4 Low Ave	110 57 75.9	760 420 698	120 60 79	130 60 77	No Data	1100 500 904	700 590 648	No Data	No Data	No Data	180 54 80	No Data	No Data	No Data
SAR High(4 Low Ave	2.9 1.7 1.9	9.8 7.0 9.25	2.7 1.6 1.98	3.2 1.6 1.9	No Data	1.2 7.5 10.7	9.4 7.8 8.48	No Data	No Data	No Data	4.4 1.4 2.02	No Data	No Data	No Data
K High(4 Low Ave	4.0 .9 2.24	12 5.4 7.8	3.0 .8 2.31	5.0 1.1 2.37	No Data	11 2.2 7.7	5.9 1.4 5.28	No Data	No Data	No Data	6.1 1.1 2.46	No Data	No Data	No Data
Cl High(4 Low Ave	68 32 41	60 25 51	79 32 42	120 33 45	No Data	74 30 60.9	43 35 37	No Data	No Data	No Data	230 34 54.	No Data	No Data	No Data

(4 mg/1 - milligram per liter

TABLE II-3 (CONTINUED)
WATER QUALITY SUMMARY
Ua-Ub Oil Shale Monitoring

Semi Monthly Sampl

Parameters Station		S1 6400	S2 6430	S3 6500	S4 6600	S5 6405	S6 0420	S7 6415	S8 6425	S9 6605	S10 6620	S11 6700	S12 6625	S13 6610	S
SO_4	High (2	210	2200	260	260	No Data	3300	2000	No Data	No Data	No Data	220	No Data	No Data	No Data
	Low	160	1200	150	160		1400	1800				160			
	Ave	181	2064	189	185		2681	1940				185			
F	High(2	.4	.9	.4	.3	No Data	1.1	2.1	No Data	No Data	No Data	.3	No Data	No Data	No Data
	Low	.2	.5	.2	.2		.6	.9				.1			
	Ave	.3	.76	.3	.23		.91	1.28				.23			
Si	High(2	17	10	18	17	No Data	11	27	No Data	No Data	No Data	17	No Data	No Data	No Data
	Low	12	6.1	10	11		6.8	9.4				11			
	Ave	14	8.7	13.9	13		9.14	14.6				13			
Phels.	High(32)	10	25	6	7	No Data	7	1	No Data	No Data	No Data	14	No Data	No Data	No Data
	Low	0	0	0	0		0	0				0			
	Ave	2.2	4.5	2.5	3.0		2.36	<1				3.57			
TDS	High(4	618	3890	710	717	No Data	5310	5410	No Data	No Data	No Data	892	No Data	No Data	No Data
	Low	489	2020	453	470		2380	2980				465			
	Ave	529	3400	552	580		4337	5250				577			
Br mg/1	High(4	.5	.4	.2	.4	No Data	.4	.3	No Data	No Data	No Data	.7	No Data	No Data	No Data
	Low	0	.2	.0	.0		.2	12				.0			
	Ave	.12	.29	.1	.12		.3	.26				.19			
l	High(42)	.3	.3	.2	.3	No Data	< .1	.3	No Data	No Data	No Data	.3	No Data	No Data	No Data
	Low	0	.1	0	0		.0	.0				.0			
	Ave	<.1	.1	.03	.1		.02	.13				.07			
	High														
	Low														
	Ave														
	High														
	Low														
	Ave														
	High														
	Low														
	Ave														
	High														
	Low														
	Ave														
	High														
	Low														
	Ave														

(2 millograms per liter
(4 micrograms per liter

TABLE II-3 (CONTINUED)

WATER QUALITY SUMMARY
OIL SHALE TRACTS Ua-Ub

Monthly Samples

Parameters Station		S1 6400	S2 6430	S3 6500	S4 6600	S5 6405	S6 0420	S7 6415	S8 6425	S9 6605	S10 6620	S11 6700	S12 6625	S13 6610	S1 6417
DO mg/1	High	11.1	13.0	11.6	10.5	No Data	10.3		(3 No Data	(3 No Data	(3 No Data	10.2	(3 No Data	(3 No Data	(3 No Data
	Low	8.0	8.1	7.0	8.2		5.3					8.2			
	Ave	9.5	9.5	9.28	9.35		7.77					9.43			
(2 CN	High	0.01 (2	0	0	0	No Data	0		No Data	No Data	No Data	0	No Data	No Data	No Data
	Low	0	0	0	0		0	0							
	Ave	.0007	0	0	0										
(2 As	High	4 (2	6 (2	3 (2	2 (2	No Data	5 (2	2 (2	No Data	No Data	No Data	3 (2	No Data	No Data	No Data
	Low	1	0	0	0		0	1				0			
	Ave	1.6	2.2	.56	1		2.5	1.67				1.22			
(2 Ba	High	100	140 (2	100 (2	100 (2	No Data	190 (2	100	No Data	No Data	No Data	100 (2	No Data	No Data	No Data
	Low	0	0	0	0		0	0				0			
	Ave	9.3	64	55	86		84	< 66				56			
(2 B	High	120 (2	2500 (2	130 (2	130 (2	No Data	2700 (2	2400 (2	No Data	No Data	No Data	190 (2	No Data	No Data	No Data
	Low	40	590	50	25		310	1300				57			
	Ave	698	1979	82	70		1868	1700				90			
(2 Cd	High	2 (2	1 (2	1 (2	15 (2	No Data	1 (2	0 (2	No Data	No Data	No Data	1 (2	No Data	No Data	No Data
	Low	0	0	0	0		0					0			
	Ave	.5	.5	.5	2.54							.2			
(2 Cr	High	20 (2	65 (2	11 (2	20 (2	No Data	90 (2	< 10 (2	No Data	No Data	No Data	11 (2	No Data	No Data	No Data
	Low	0	0	0	0		0	0				0			
	Ave	4	10.5	3.1	4.46		17	< 3.3				3.1			
(2 Co	High	10 (2	65 (2	11 (2	10 (2	No Data	90 (2	1 (2	No Data	No Data	No Data	11 (2	No Data	No Data	No Data
	Low	1	0	0	0		0	0				0			
	Ave	1.1	6.8	1	1.54		13	.33				1.2			
(2 Cu	High	20 (2	600 (2	6 (2	160 (2	No Data	20 (2	4 (2	No Data	No Data	No Data	340 (2	No Data	No Data	No Data
	Low	0	1	1	0		3	2				1			
	Ave	4.8	79	2.8	40		6.8	2.6				47			
(2 Fe	High	40 (2	100 (2	270 (2	100 (2	No Data	220 (2	20 (2	No Data	No Data	No Data	140 (2	No Data	No Data	No Data
	Low	10	20	10	5		20	10				10			
	Ave	20	39	20	32		62	16				37			
(2 Pb	High	10 (2	65 (2	11 (2	10 (2	No Data	90 (2	3 (2	No Data	No Data	No Data	11 (2	No Data	No Data	No Data
	Low	0	0	0	0		0	0				0			
	Ave	2	8.1	2.0	2.23		13	1				2.5			
(2 Mn	High	20 (2	190 (2	30 (2	20 (2	No Data	210 (2	42	No Data	No Data	No Data	10 (2	No Data	No Data	No Data
	Low	0	20	0	0		10	30				0			
	Ave	5	86	8.5	5.62		118	37				2.6			

(1 Anomoly
(2 micrograms per liter

(3 Dry Wash Data

TABLE II-3 (CONTINUED)

WATER QUALITY SUMMARY
Ua- Ub Oil Shale Monitoring

Monthly Samples

Parameters Station		S1 6400	S2 6430	S3 6500	S4 6600	S5 6405	S6 0420	S7 6415	S8 6425	S9 6605	S10 6620	S11 6700	S12 6625	S13 6610	S15 6417
2) Mo	High	(2 5	67	(2 4	(2 5	No Data	46	67	No Data	No Data	No Data	4	No Data	No Data	No Data
	Low	0	20	1	0		20	38				1			
	Ave	2.5	48	2.6	2.6		35	48				2.8			
2) Ni	High	16 (2	65	11 (2	13 (2	No Data	90	16	No Data	No Data	No Data	16	No Data	No Data	No Data
	Low	1	0	0	0		0	6				0			
	Ave	5	10.8	3.5	5.3		20.7	10.6				5.9			
2) V	High	5.1 (2	65	11 (2	10 (2	No Data	90	2.5	No Data	No Data	No Data	11	No Data	No Data	No Data
	Low	0	0	0	0		0	0				0			
	Ave	2.3	7.4	2.4	2.23		15.5	.93				2.0			
2) Zn	High	180 (2	60	110 (2	30	No Data	40	20	No Data	No Data	No Data	360	No Data	No Data	No Data
	Low	0	10	10	0		10	10				10			
	Ave	30	27	26	13.85		17	13				65			
2) Al	High	45 (2	230	50 (2	80	No Data	300	0	No Data	No Data	No Data	60	No Data	No Data	No Data
	Low	0	0	0	0		0	0				0			
	Ave	11	43	20	22.5		48	0				22			
2) Li	High	30 (2	150	30 (2	60	No Data	120	140	No Data	No Data	No Data	110	No Data	No Data	No Data
	Low	0	50	0	0		60	80				0			
	Ave	16	120	12	16		104	103				22			
2) Se	High	2 (2	2	2 (2	4	No Data	7	20	No Data	No Data	No Data	2	No Data	No Data	No Data
	Low	1	0	1	1		0	6				1			
	Ave	1.3	1.12	1.25	1.89		1	11				1.2			
5)Gr. B-C_s 137	High	5.6	66	12.0	9.6	No Data	170	16	No Data	No Data	No Data	8.4	No Data	No Data	No Data
	Low	2.5	16	3.0	2.0		20	40				2.5			
	Ave	3.7	28	5.8	5.58		47	43				4.38			
2)Chlorophyll A	High	4.3 (2	13	5.8 (2	7.2	No Data	19	1.3	No Data	No Data	No Data	4.9	No Data	No Data	No Data
	Low	1.0	.0	0	0		.4	.2				0			
	Ave	2.0	4.9	2.3	3.0		4.6	.75				2.47			
2)Chlorophyll B	High	5.7 (2	5.4	2.5 (2	5.6	No Data	4.0	1.0	No Data	No Data	No Data	8.4	No Data	No Data	No Data
	Low	.6	.5	.5	0		.5	.3				0			
	Ave	2.8	2.9	1.05	2.0		1.9	.65				1.94			
5) Gross A-	High	13 (5	280	(5	25	No Data	120 (5	50 (5	No Data	No Data	No Data	31 (5	No Data	No Data	No Data
	Low	4.1	50		7.4		30	32				6.8			
	Ave	8.7	95		11.13		62	41				12.13			
5)GR.B Sr90/ y90	High	4.6 (5	53	(5	8.0	No Data	140 (5	14 (5	No Data	No Data	No Data	7.2 (5	No Data	No Data	No Data
	Low	2.0	14		1.6		13	8.4				2.1			
	Ave	3.3	24		4.3		38	11.2				3.63			

(5 Picocurries

TABLE II-3 (CONTINUED)

WATER QUALITY SUMMARY
Ua-Ub Oil Shale Monitoring

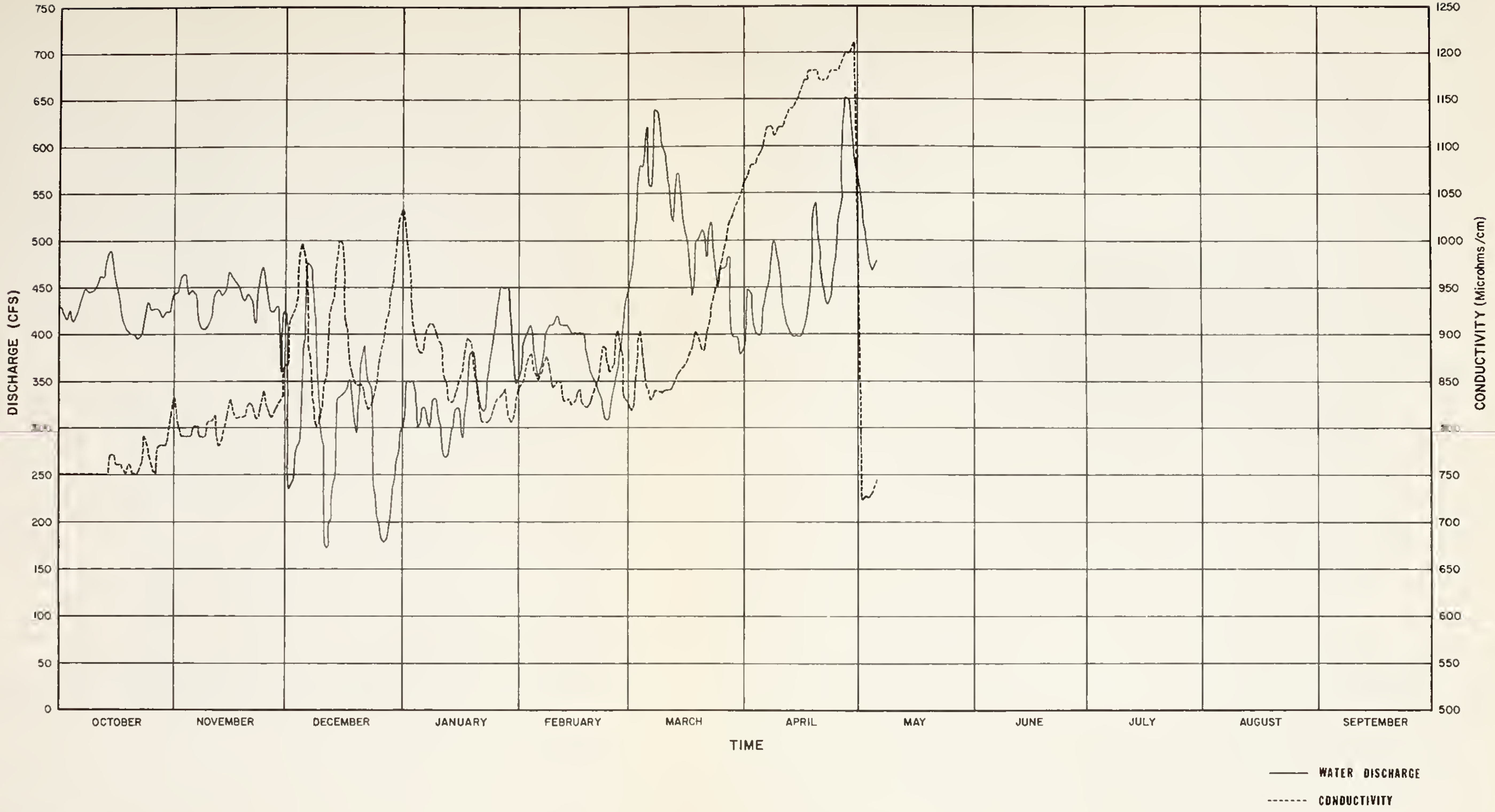
Quarterly Samples

Parameters Station		S1 6400	S2 6430	S3 6500	S4 6600	S5 6405	S6 0420	S7 6415	S8 6425	S9 6605	S10 6620	S11 6700	S12 6625	S13 6610	S15 6417
	High	5.5	13	13	8.0	No	22	15	No	No	No	7.7	No	No	No
TOC	Low	2.1	8.1	4.1	3.1	Data	21		Data	Data	Data	4.5	Data	Data	Data
mg/1	Ave	3.77	10.7	7.2	6.0		21.5					6.23			
4)	High	10	14	10	10	No	20		No	No	No	10	No	No	No
Be	Low	0	0	0	0	Data	10	10	Data	Data	Data	0	Data	Data	Data
	Ave	5.75	6	5	4		15					5.5			
4)	High	1	7	2	2	No	9		No	No	No	2	No	No	No
Ag	Low	0	0	0	0	Data	1	0	Data	Data	Data	0	Data	Data	Data
	Ave	.1	1.8	.6	.43		3.3					16			
4)	High	1100	4200	1100	1300	No	5300		No	No	No	1300	No	No	No
St	Low	900	3800	800	900	Data	4100	4100	Data	Data	Data	870	Data	Data	Data
	Ave	992	3980	968	1082		4560					1054			
	High														
	Low														
	Ave														
	High														
	Low														
	Ave														
	High														
	Low														
	Ave														
	High														
	Low														
	Ave														
	High														
	Low														
	Ave														
	High														
	Low														
	Ave														
	High														
	Low														
	Ave														
	High														
	Low														
	Ave														

TABLE II-3 (CONTINUED)
WATER QUALITY SUMMARY
Ua-Ub Oil Shale Monitoring

Semi Annual

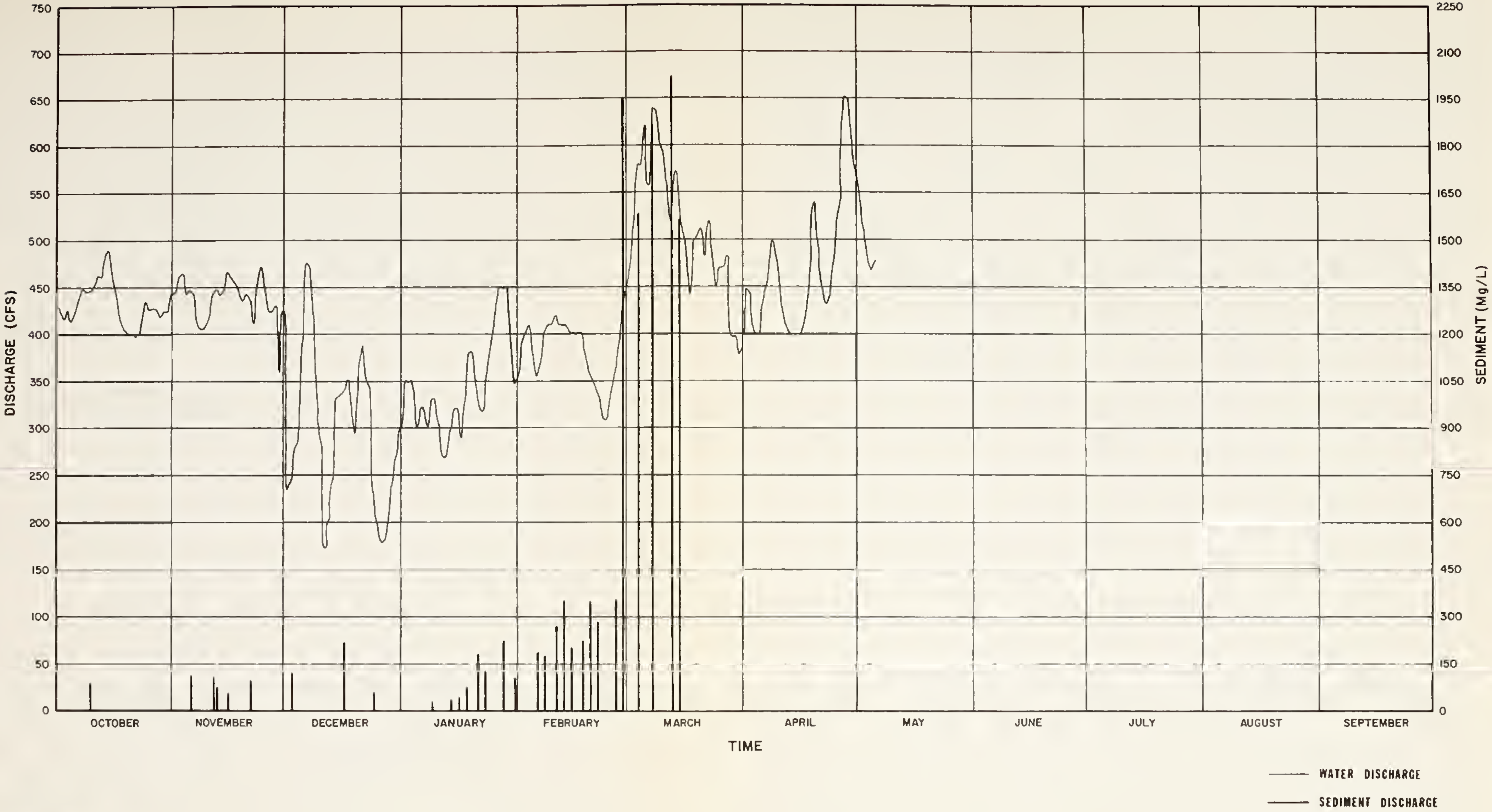
Parameters Station		S1 6400	S2 6430	S3 6500	S4 6600	S5 6405	S6 0420	S7 6415	S8 6425	S9 6605	S10 6620	S11 6700	S12 6625	S13 6610	S15 6417
2) Bl	High	<10 (2	<65	<11 (2	<12	No Data	<90		No Data	No Data	No Data		(3 No Data	(3 No Data	(3 No Data
	Low		<20	<10	<4										
	Ave		<42	10.5	<7.5										
2) S	High		<65	<11	<10	No Data	<90		No Data	No Data	No Data	<12	No Data	No Data	No Data
	Low	<10	<20	<8	<4							<11			
	Ave		<42	<6	<7							11.5			
2) Ga	High		<30	<5	<5	No Data			No Data	No Data	No Data	<6	No Data	No Data	No Data
	Low	<5	<5	<4	<2		<40					<5			
	Ave		<17	<4.5	<3.5							5.5			
2) Ge	High		<65		<14	No Data			No Data	No Data	No Data	17	No Data	No Data	No Data
	Low	<10	<20	<11	<4		<90					11			
	Ave		<42		<8							14			
2) Ti	High		<45	<8	<8	No Data			No Data	No Data	No Data	8	No Data	No Data	No Data
	Low	<8	<13	<5	<3		<60					8			
	Ave		<29	<6.5	<5.25							8			
2) Zr	High		<110	<18	<20	No Data			No Data	No Data	No Data	20	No Data	No Data	No Data
	Low	<18	<20	<12	<9		<150					18			
	Ave		<65	<15	<13.25							19			
Pesticides	High					No Data			No Data	No Data	No Data		No Data	No Data	No Data
	Low	0	0	0	0		0					0			
	Ave														
	High														
	Low														
	Ave														
	High														
	Low														
	Ave														
	High														
	Low														
	Ave														
	High														
	Low														
	Ave														
	High														
	Low														
	Ave														



CONDUCTIVITY DISCHARGE RELATIONSHIP

WHITE RIVER NEAR WATSON (09306500-S-3)

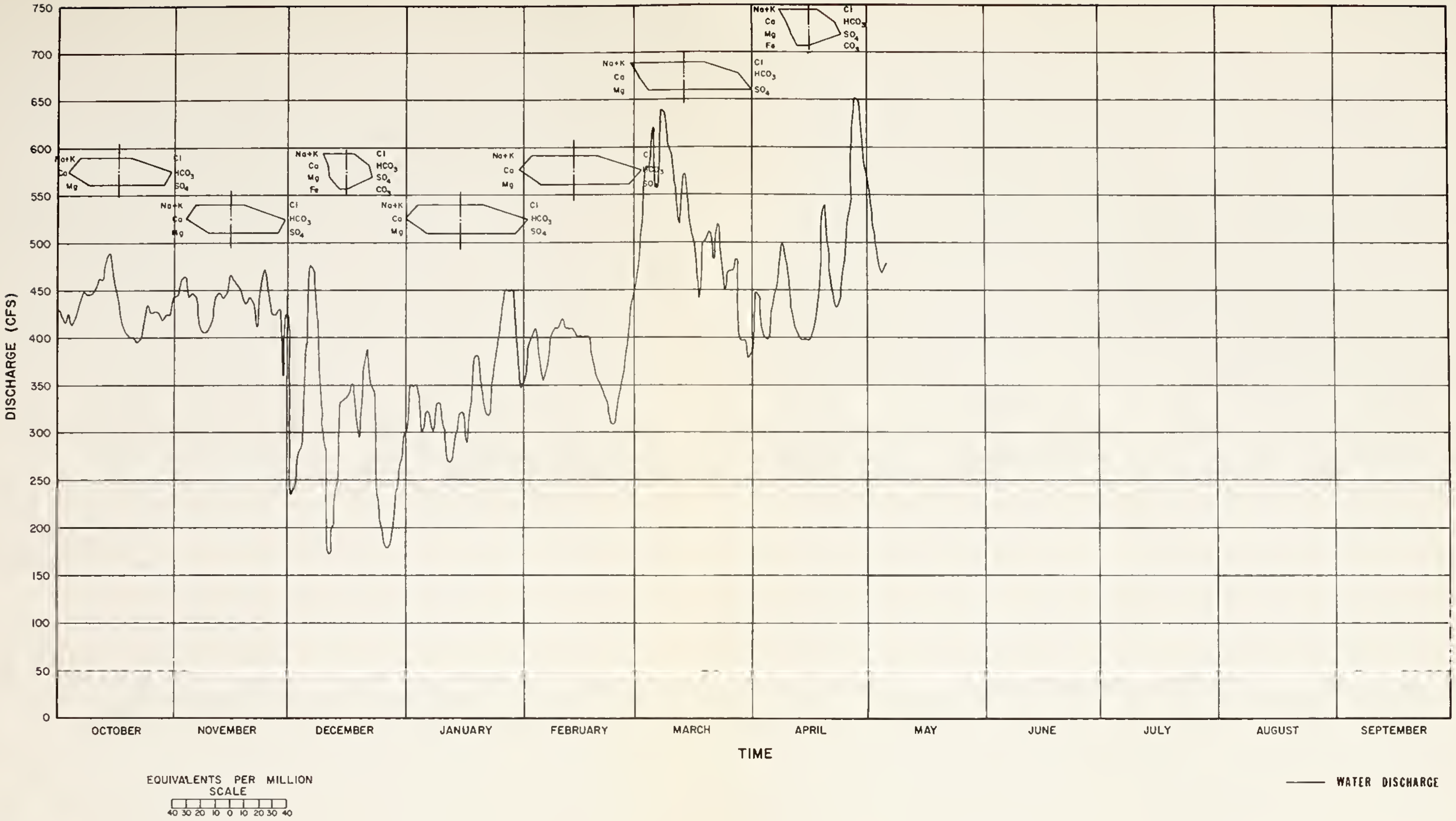
FIGURE II-1



SEDIMENT DISCHARGE RELATIONSHIP

WHITE RIVER NEAR WATSON (09306500-S-3)

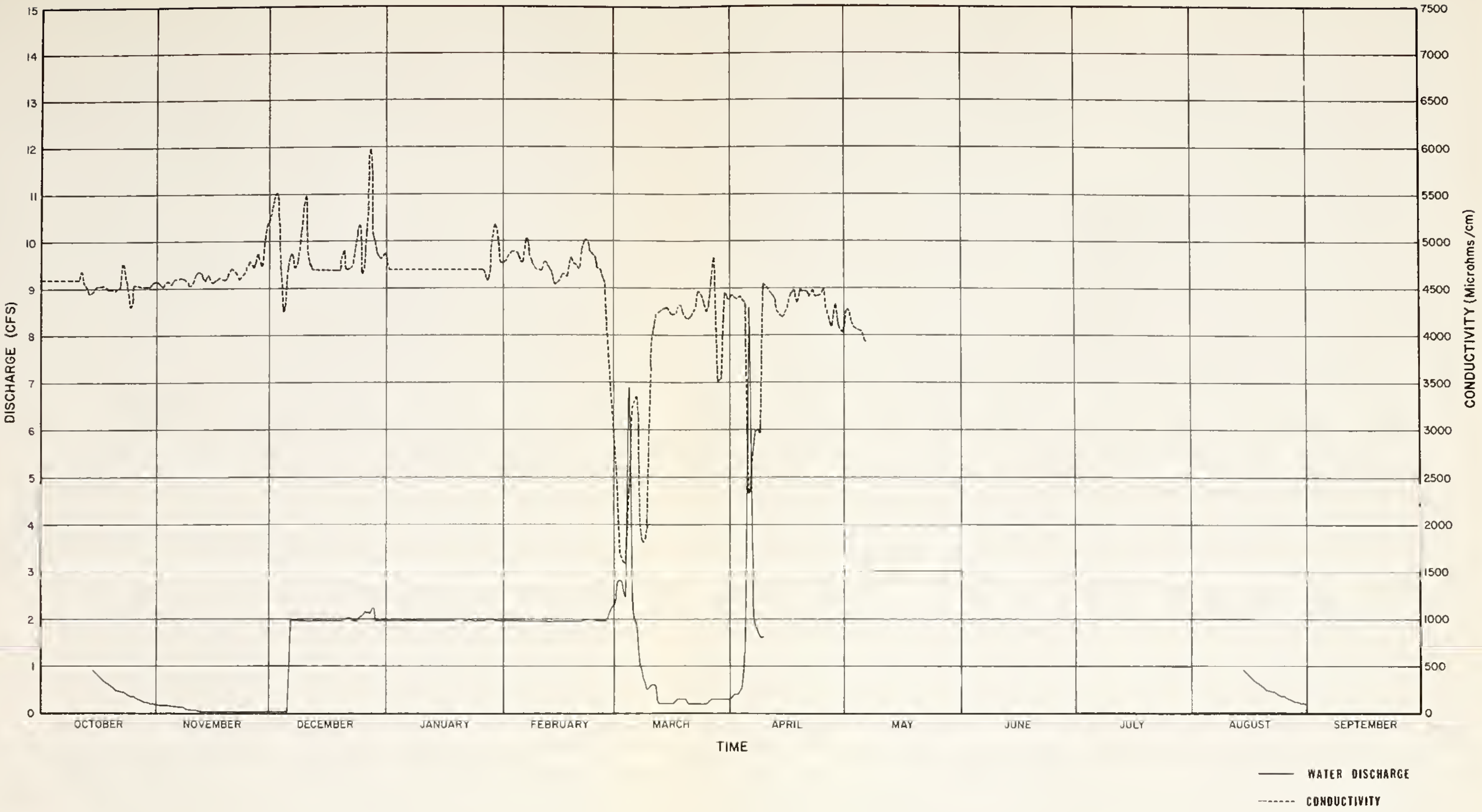
FIGURE II-2



SURFACE WATER QUALITY SUMMARY

WHITE RIVER NEAR WATSON (09306500-S-3)

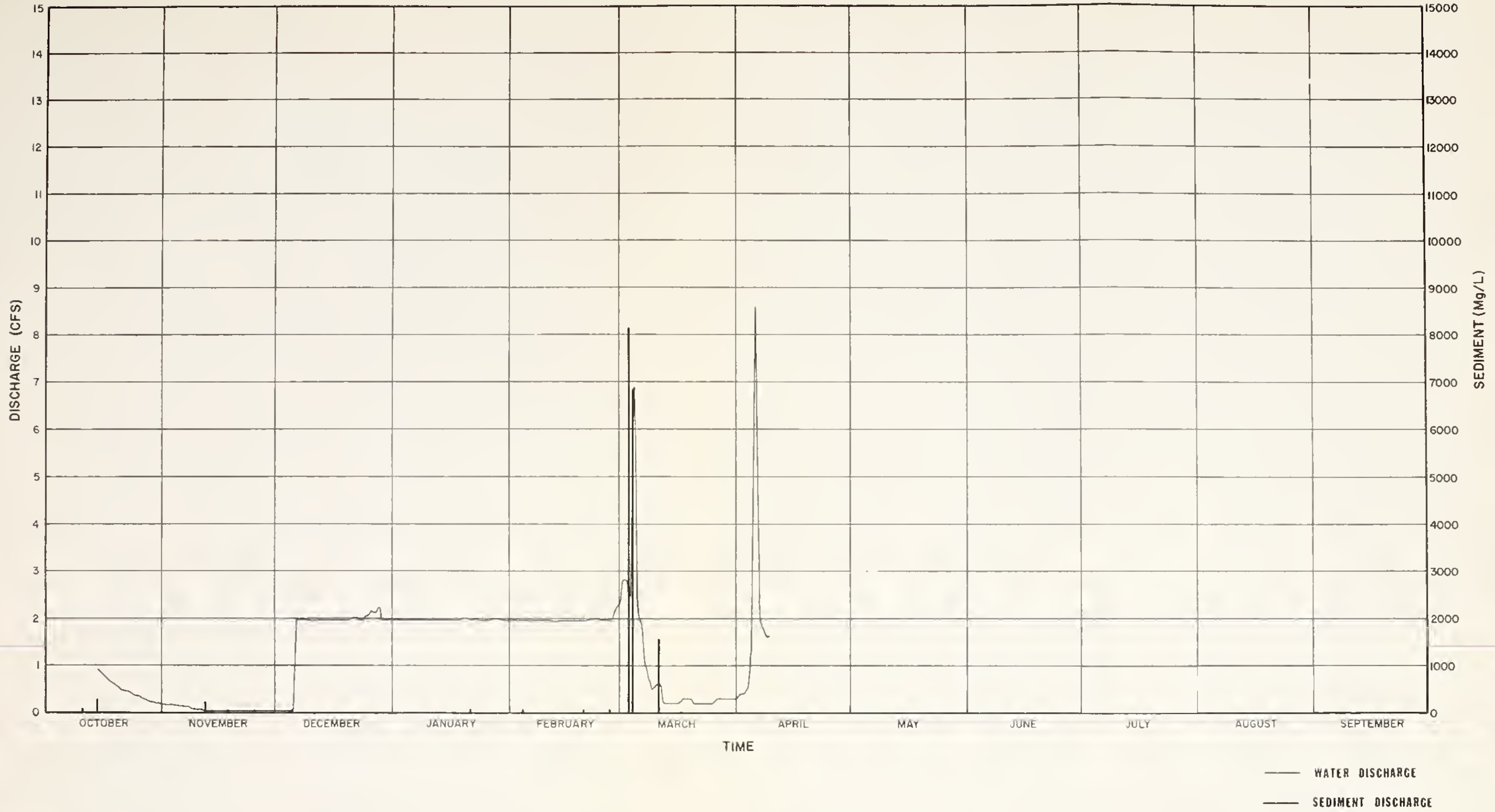
FIGURE II-3



CONDUCTITITY DISCHARGE RELATIONSHIP

EVACUATION CREEK (09306430-S-2)

FIGURE II-4



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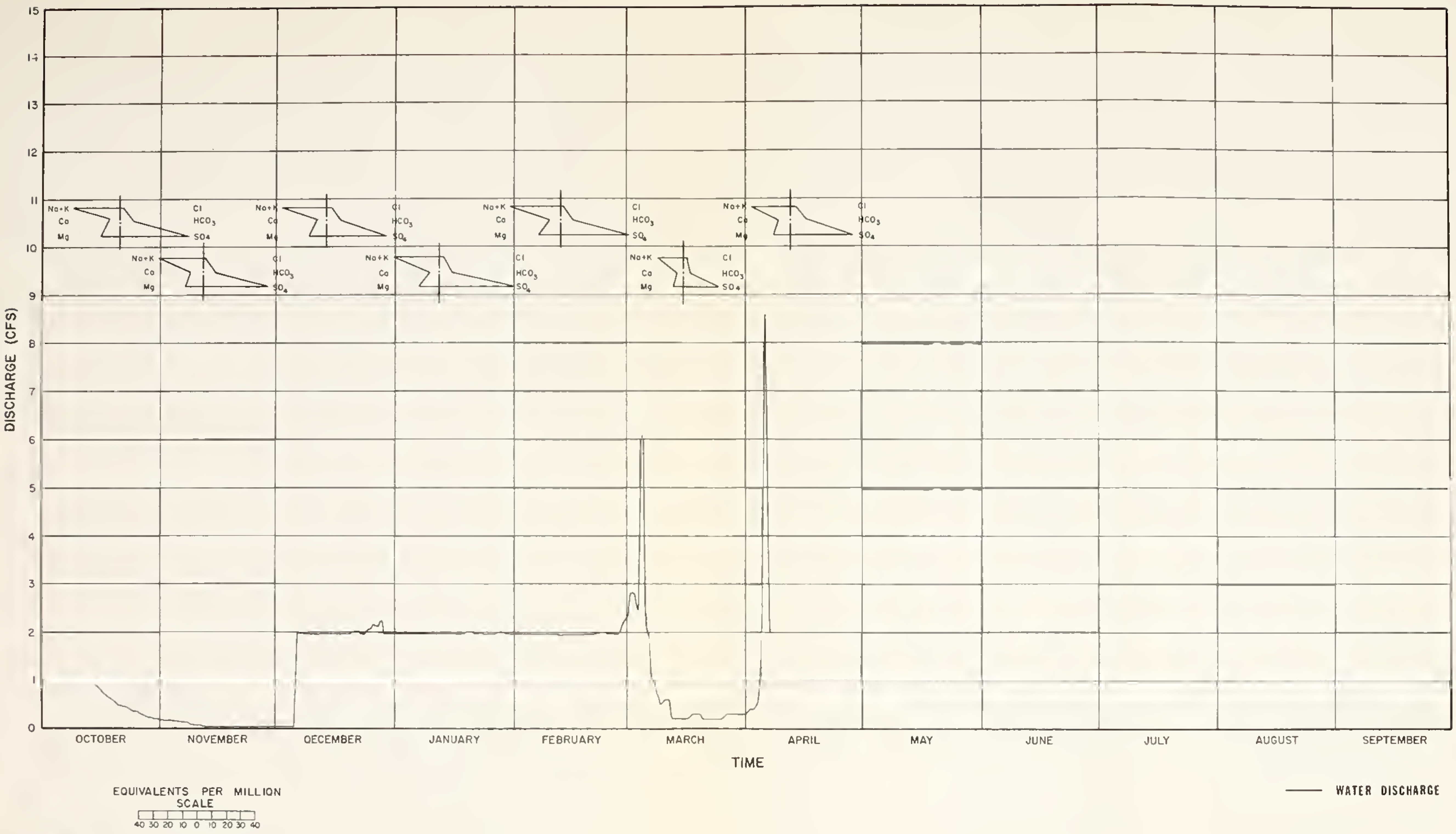
SEDIMENT DISCHARGE RELATIONSHIP

EVACUATION CREEK (09306430-S-2)

FIGURE II-5



SURFACE WATER QUALITY SUMMARY

EVACUATION CREEK (09306430-S-2)

FIGURE II-6

The stiff diagrams for the White River and Evacuation Creek, Figures II-3 and II-6, respectively, illustrate the periodic changing conditions for two different ecochemical systems. Evacuation Creek (Figure II-6) is classified Na and SO_4-rich water, whereas the White River (Figure II-3) is classified Na, Ca, and HCO_3.

Figures II-4 through II-6 summarize similar characteristics for Station S-2. The conductivity-discharge relationship (Figures II-1 and II-4) for the White River and Evacuation Creek illustrates that as stream flow increases the conductivity decreases (i.e., they are inversely related). The sediment discharge relationships (Figure II-2 and II-5) will be described in detail in the next quarterly; however, it is apparent that stream flow discharge and sediment loads are directly related. Table II-4 summarizes the suspended sediment loads for Stations S-1, S-2, S-3, S-4, S-6, S-7 and S-11 and indicates that as discharge increases the sediment load increases. The correlation analyses will be presented in the next quarterly with a complete description of sediment-discharge relations for all surface gaging stations. The surface water quality summaries, Figures II-3 and II-6, illustrate water quality variation between Evacuation Creek and the White River. The stiff diagrams indicate little variation in quality between months which have similar flows, but as flows change, the balance between predominant ions in the water also changes.

TABLE II-4

Suspended Sediment Sample Analysis

WHITE RIVER - HELL'S HOLE CANYON
S1 - 09036400

Date	Instantaneous Discharge (cfs)	Ave Temp (C°)	Sediment Date (Month)	Sediment Conc. mg/l	No. of Samples
10/1/74			10	122	7
10/4/74	443				
10/9/74	467				
10/14/74	471				
10/22/74	434				
10/24/74	440		11	458	14
10/28/74	449				
11/4/74	467	5.76			
11/8/74	450	4.75			
11/11/74	482	.42			
11/15/74	441	3.7	12	174	4
11/21/74	439	1.0			
11/26/74	428	.55			
1/9/75	418	.4			
1/14/75	165	.45			
3/18/75	409	1.4	1	559	17
3/20/75	514	1.93			
3/25/75	409	4.6			
3/27/75	430	3.5			
4/3/75	341	3.6			
4/10/75	402	3.6	2	423	15
4/24/75	481	10.1			
5/1/75	540	8.8			
5/8/75	599	9.1			
5/16/75	1027	16.1			
5/27/75	1501	12.8	3	1615	4
5/29/75	1859	11.6			
6/5/75	2357	17.4			

TABLE II-4 (CONTINUED)

Suspended Sediment Sample Analysis

Evacuation Creek 6430
S-2 0903 6430

Date	Instantaneous Discharge (cfs)	Ave Temp (C°)	Sediment Date (Month)	Sediment Conc mg/1	No. of Samples
			10/74	173	2
			11/74	82	4
			12/74	92	2
			1/75	50	3
3/6	1.59	10-17			
3/13	.56	2.5-8.8			
3/17	.72	3.3-11	2/75	67	4
3/21	.64	5.3-16			
3/24	.25	6.2-11			
3/28	.29	1.1-3.3			
4/1	.30	5-7			
4/8	1.14	2.4-7.7	3/75	4353	11
4/15	.74	11.3-17.4			
4/22	1.17	15.1-21.1			
4/29	1.50	10.6-11.1			
5/13	.75	16.4-26.6			
5/20	1.84	16.2-17.7			
5/28	44.7	11.2			
5/29	78.3	8.0			

TABLE II-4 (CONTINUED)

Suspended Sediment Sample Analysis

White River near Watson
S-3 - 09036500

Date	Instantaneous Discharge (cfs)	Ave Temp (C°)	Sediment Date (Month)	Sediment Conc. mg/l	No. of Samples
10/17/74	462				
11/5/74	506	35.3	10/74	88	1
11/11/74	488	5.0			
11/19/74	432	2.6			
11/21/74	439	2.03			
12/2/74	181	0			
12/16/74	381	0			
1/24/75	236	0.2			
1/27/75	445	0			
1/13/75	314	.35			
1/20/75	354	.46	11/74	85	12
1/22/75	327	.25			
1/24/75	396	1.1			
1/27/75	475	0.3			
1/29/75	399	1.0			
2/3/75	412	.70	12/74	115	8
2/5/75	-	-			
2/7/75	404	.40			
2/10/75	416	.35			
2/12/75	411	.40			
2/17/75	396	.10	1/75	117	21
2/19/75	362	.10			
2/21/75	341	.10			
2/24/75	306	.12			
2/26/75	358	.15			
3/3/75	523	.35	2/75	405	21
3/10/75	594	.30			
3/12/75	584	.84			
3/14/75	585	.70			
3/21/75	497	6.8			
3/26/75	423	4.21	3/75	1757	
3/31/75	333	3.0			
4/3/75	386	1.5			
4/10/75	437	5.6			
4/14	377	8.8-14			
4/17	431	8.8			
4/21	446	9.7			
4/24	477	10.6			
4/29	628	7.24			
5/1	539	9.6			

TABLE II-4 (CONTINUED)

Suspended Sediment Sample Analysis

White River Near Watson (Cont.)
S-3 09036500

Date	Instantaneous Discharge (cfs)	Ave Temp (C°)	Sediment Date (Month)	Sediment Conc. mg/1	No. of Samples
5/8	593	8.3			
5/12	516	13.1			
5/15	883	17			
5/19	2044	14.6			
5/21	2223	11.9			
5/27	1736	13.3			
5/29	2017	11.8			
6/24	2287	15.7			

TABLE II-4 (CONTINUED)

Suspended Sediment Sample Analysis
White River Above Southam Canyon
S-4-09036600

Date	Instantaneous Discharge (cfs)	Ave Temp (C°)	Sediment Date (Month)	Sediment Conc. mg/1	No. of Samples
10/2/74	436				
10/7/74	463		10/74	308	13
10/10/74	469				
10/15/74	491				
10/25/74	463		11/74	218	13
10/31/74	473	35.5			
11/7/74	444	34.4			
11/12/74	465	4.2			
11/18/74	422	2.8			
11/20/74	427	2.9	12/74	359	10
11/25/74	413	1.2			
11/27/74	428				
12/12/74	286	.8	1/75	165	14
12/16/74	387	.4			
12/23/74	405	.5			
12/30/74	272	.55	2/75	143	16
1/7/75	346	.8			
1/23/75	329	.4			
3/18/75	381	1.9	3/75		
3/21/75	482	3.8			
3/25/75	449	4.5			
4/3/75	413	3.4			
4/10/75	385	4.2			
4/17/75	430	9.8			
4/24/75	474	10.1			
5/1/75	488	9.3-15.5			
5/8/75	601	10.4			
5/27/75	2,721	10.3			
5/29/75	1,956	11.7			

TABLE II-4 (CONTINUED)

Suspended Sediment Sample Analysis
Evacuation Creek At Watson
S-6-07036420

Date	Instantaneous Discharge (cfs)	Ave Temp (C°)	Sediment Date (Month)	Sediment Conc. mg/l	No. of Samples
			10/74	244	1
	.04	.0	11/74	144	6
	.17		12/74	1,546	4
	.1		1/75	88	3
Instantaneous Discharge Readings					
3/24	.14	3.1			
3/26	1.01	4.3			
4/2	1.07	1.6			
4/2	1.07	2.4	2/75	114	4
4/20	1.11	9.1			
4/23	1.16	10.4			
4/30	1.11	6.9			
5/14	.97	19.2	3/75	2,344	4
5/23	1.21	9.1			
5/28	1.53	9.3			
5/29	1.25	9.4			
5/30	.93	19.4			

TABLE II-4 (CONTINUED)

Suspended Sediment Sample Analysis
Evacuation Creek Below Pack Canyon
S-7 09306415

Date	Instantaneous Discharge (cfs)	Ave Temp (C°)	Sediment Date (Month)	Sediment Conc. mg/1	No. of Samples
			10/74	421	
			11/74	421	9
			12/74	1,881	1
Instantaneous Discharge Readings			1/75	1,891	4
5/1/75	1.03	10.7			
5/9/75	1.59	13.8			
5/16/75	.40	12.1			
5/23/75	6.42	9.9	2/75	411	3
5/29/75	50.77	7.9			
			3/75	1,940	8

TABLE II-4 (CONTINUED)

Suspended Sediment Sample Analysis
White River Below Asphalt Wash
S11-09036700

Date	Instantaneous Discharge (cfs)	Ave Temp (C°)	Sediment Date (Month)	Sediment Conc. mg/1	No. of Samples
10/3/74	464		10/74	2,321	5
10/8/74	464				
10/11/74	485				
10/16/74	479				
10/23/74	461				
10/28/74	466		11/74	2,891	14
11/1/74	496	35.5			
11/6/74	455	34.5			
11/12/74	451	3.45			
11/14/74	391	3.8			
11/20/74	400	1.8	12/74		
11/25/74	445	-			
11/27/74	414	1.7			
12/18/74	-				
12/23/74	-				
1/6/75	283	.5	1/75	2,151	15
1/17/75	498	.3			
3/17/75	443	.2			
3/19/75	408	2.5			
3/24/75	425	4.6			
4/3/75	415	3.3	2/75	1,831	25
4/24/75	435	-			
5/22/75	2,675	9.8			
5/29/75	1,973	11.0			
6/9/75	3,814	13.2			
			3/75	1,004	9

Trace element, heavy metal, and biochemical analyses have remained relatively constant from sample to sample, as illustrated in Table II-3 and the accompanying raw data information. The table summarizes the maximum, minimum and means of the water quality constituent concentrations.

3. GROUND WATER

Table II-5 is a tabulation of regional data derived from selected wells on and around the tracts. The data suggest that aquifer thickness ranges from 92 feet to a possible maximum of 172 feet. Water level and water quality values available from the deep off-tract oil and gas test wells contribute little, if any, information regarding the regional hydraulic characteristics of the bird's nest aquifer. Inspection of the geophysical logs of these holes suggests additional water-bearing zones of differing water quality at depths below the level of the bird's nest aquifer. These additional zones, or at least some of them, are under a higher hydrostatic pressure than that of the bird's nest aquifer, causing water levels measured in these wells to reflect a significantly higher head.

a. Summary Report: Tract Aquifer-Evacuation Creek Interrelationship

The following report describes the field investigation of Evacuation Creek conducted by VTN hydrogeologists.

Bird's Nest Aquifer

The only well-defined aquifer zone which may be influenced by mining operations on the tracts occurs about 50 to 125 feet below

TABLE II-5 REGIONAL AQUIFER DATA, BIRDS NEST AQUIFER NEAR THE TOP OF THE GREEN RIVER FORMATION, SOUTHEAST UINTAH BASIN, UTAH.

WELL NO.	LOCATION	SURF. ELEVATION	AQUIFER INTERVAL (Depth in Ft.)	AQUIFER THICKNESS (Ft.)	ELEV. TOP OF AQUIFER	WELL DEPTH (FT.)	OPERATOR	DATA AVIALABLE IN AQUIFER ZONE Electric Log,	Gamma Ray,	Neutron,	Caliper,	Formation Density,	Sonic,	Temp.,	Flow
2	C NW SE 24-9S/23E	5643	1356-1478	122	4289	7236	Pacific Nat. Gas	X	X	X	X	X	X		
3	NW SE 02-10S/23E	5461	1543-1560	115	3916	5226	Humble Oil		X	X					
4	NW NE NE 11-10S/23E	5492	1430-1520	90	4062	5049	El Paso Nat. Gas Co.	X							
5	NE NE NW 14-10S/23E	5537	1345-1550	205	4242	8502	Gulf Oil Corp.	X	X	X					
6	NE NE SE 15-10S/23E	5613	1410-1575	165	4203	7418	El Paso Nat. Gas Co.	X	X	X					
7	NW NW 24-10S/23E	4932	520-640	120	4412	6486	Shell Oil Co.	X	X				X		
8	NE NE 35-10S/23E	*5078	370-500	130	4708	924	Shell Oil Co.	X							
9	NE SW 03-10S/23E	5334	1415-1535	120	3919	5858	Belco Pet. Corp.	X					X		
10	NW NE SE 30-10S/24E	5294	602-710	108	4692	1141	White R. Sh. Project	X	X	X	X	X	X	X	X
11	SW SE 28-10S/24E	5392	514-620	106	4878	7048	El Paso Nat. Gas	X			X				
12	NE NE 29-10S/24E	5260	542-660	118	4718	6030	El Paso Nat. Gas	X			X				
13	C NE SW 32-10S/24E	*5460	610-715	105	4870	7033	Shell Oil Co.	X					X		
14	NE SW 22-10S/24E	5292	490-605	115	4802	6161	Noab Drilling Co.	X			X		X		
15	S/2 SW SW 14-10S/24E	5242	408-522	114	4834	958	White River Sh. Project	X	X	X	X	X	X	X	X
16	SW NW 24-10S/24E	5417	380-515	135	5037	4249	Continental Oil Co.	X	X	X					
20	NW NW SW 02-11S/23E	5550	620-740	120	4930	8038	Gen. Pet. & Stanolind	X							
22	NW SE 11-11S/23E	5989	890-1000	110	5099	5901	Shamrock Oil & Gas Co..	X							
23	SW SE 13-11S/23E	5617	325-455	130	5292	5863	Shamrock Oil & Gas Co.	X							
24	SE NW 14-11S/23E	5958	875-1000	125	5083	6649	Shamrock Oil & Gas Co.	X							
25	SE SE 10-11S/23E	5849	762-900	138	5087	7384	Shamrock Oil & Gas Co.	X							
28	NE SW 18-11S/24E	5367	275-400	125	5292	5581	Shamrock Oil & Gas Co.	X							
29	SE SE 15-11S/23E	6076	872-970	98	5204	6467	Shamrock Oil & Gas Co.	X							
30	NE SW 05-11S/24E	5270	211-310	99	5059	2521	Shamrock Oil & Gas Co.	X							
X-9	NW SE NW 27-10S/24E	5427	553-651	98	4874	1068	White R. Sh. Project	X	X	X	X	X	X	X	X
G-29	SE NE NW 24-11S/24E	5832	190-325	135	5642	800	White R. Sh. Project		X	X	X	X			
X-2	NW NE NW 14-10S/24E	4954	213-326	113	4771	766	White R. Sh. Project	X	X	X	X	X		X	X
P-3	SE SE SW 26-10S/24E	5498	370-480	110	5128	711	White R. Sh. Project	X	X	X	X	X		X	X
P-1	NE SE SW 12-10S/24E	5284	300-435	135	4984	1225	White R. Sh. Project	X	X	X	X	X		X	X
X-3	C NE NW 18-10S/25E	5205	90-260	170	5205	586	White R. Sh. Project	X	X	X	X	X	X	X	X
X-6	C NW 19-10S/25E	5472	274-379	105	5198	806	White R. Sh. Project	X	X	X	X	X	X	X	X
P-4	NE SE SE 19-10S/25E	5719	346-482	136	5343	1170	White R. Sh. Project		X	X	X	X			
HS-4	NW NE NW 20-10S/24E	5061	495-667	172	4566	1076	Gulf Oil Corp.	X	X	X					
P-2	NW NE NE 20-10S/24E	4991	404-500	96	4587	1290	White R. Sh. Project	X	X	X	X	X	X	X	X

*Feet above mean sea level

the top of the Green River Formation. Its average thickness is approximately 100 feet. In general, the aquifer strata are hard, well-cemented siltstone and fine sandstone with thin interbeds of crumbly marlstone.

The upper portion of the aquifer contains a markedly consistent bed, 5 to 20 feet thick, of slightly cemented fine-grained sandstone with relatively high permeability. Outcrops of this bed in Evacuation Creek canyon are usually moist and almost always covered with white salt deposits which indicate past ground water seepage and evaporation (Figure II-7). For this reason the sandstone was informally named the "weeper" bed. The total zone of water-bearing strata is informally known as the bird's nest aquifer because of its characteristic appearance. Outcrops of the bottom two-thirds of the strata reveal numerous elongate cavities usually less than 2 feet in diameter with rough, prickly inside surfaces. These cavities were formed by ground water dissolution of nodules of nahcolite, a sodium-bicarbonate mineral. In many places, nearly vertical open joints extend throughout the aquifer's thickness and cut through these "bird's nests." The diversity of joints is greater in the aquifer than in surrounding strata. Along Evacuation Creek, beds of this aquifer strike north 20 degrees east and dip approximately 250 feet per mile to the northwest. Two dominant sets of nearly vertical joints occur throughout the region and influence the permeability of the aquifer; the sets trend primarily north 22 degrees east. The dip of both sets is about 88 degrees northwest.

LEGEND

⁚ SALT OEPOSITS WHICH INDICATE EVIOENCE OF GROUNO WATER SEEPAGE

♀ FLOWINC SPRINGS

—— EPREMERAL STREAM

--- ORY WASR

MEASUREMENTS OF TEMPERATURE ANO SPECIFIC CONOUCTANCE

- ● EVACOATION CREEK (SHOWN EAST OF CREEK)
- ○ SPRINCS FROM BIROS NEST AQUIFER (SHOWN WEST OF CREEK)

OATE ANO TIME: 5/8,1725
TEMPERATURE, IN OEGREES CELSIUS: 16.3
SPECIFIC CONOUCTANCE, IN MICRONMS/CM: 4700

ELEVATION POINTS ALONG THE BIROS NEST AQUIFER

❶ ELEVATION POINT ON BIROS NEST AQUIFER CONTACT, WITH STATION NUMBER

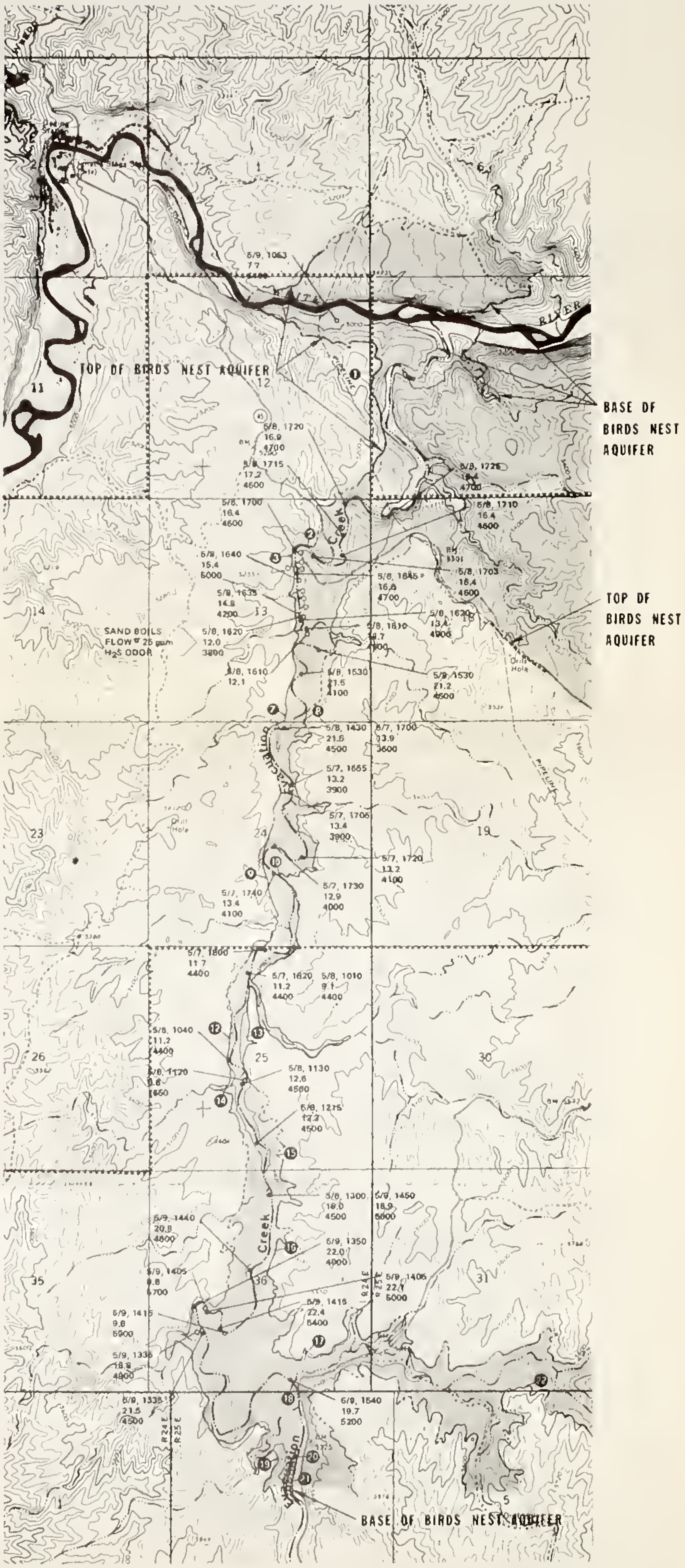
POINT	ELEVATION	LOCATION		DESCRIPTION
EP 1	5183.5	N602,270	E2,657,920	Top of Aquifer
EP 2	5118.0	N598,645	E2,656,522	Top of Aquifer Near steep edge
EP 3	5099.5	N598,410	E2,656,170	Top of Aquifer Near steep edge
EP 4 (X-3)	5295.5	N598,774	E2,659,572	
EP 6	5130.0	N596,862	E2,656,305	
EP 6	5167.0	N596,780	E2,657,243	
EP 7	5119.5	N594,650	E2,656,174	
EP 8	5147.5	N594,500	E2,656,570	
EP 9	5177.2	N590,755	E2,655,718	
EP 10	5168.8	N590,842	E2,656,100	
EP 11	5191.0	N588,335	E2,655,470	
EP 12	5212.0	N585,954	E2,654,994	
EP 13	5221.0	N585,965	E2,655,445	
EP 14	5229.0	N585,795	E2,655,011	
EP 15	5292.0	N584,152	E2,656,200	
EP 16	5323.5	N581,905	E2,656,277	On Steep Edge
EP 17	5417.5	N579,522	E2,657,012	
EP 18	5426.5	N578,560	E2,657,151	
EP 19	5425.0	N577,080	E2,656,534	
EP 20	5307.0	N577,010	E2,656,895	
EP 21	5315.0	N576,500	E2,656,821	
EP 22_1	5088.0	N601,028	E2,658,999	Base of Aquifer Steep edge
EP 22_2	5560.0	N578,805	E2,662,270	
EP 23	5086.0	N603,405	E2,659,450	Base of Aquifer

······ DIL SHALE TRACTS U-a & U-b BOUNDARIES

UTAH

N

2000 0 2000
SCALE IN FEET



HYDROGEOLOGIC MAP OF EVACUATION CREEK, TRACTS U-a & U-b

FIGURE II-7

The interval from the top of the aquifer to the top of the Green River Formation consists of 50 to 125 feet of thinly-bedded gray siltstones and shales. This sequence is not nearly as jointed as the aquifer and forms an aquiclude which allows the aquifer to attain an artesian head of about 240 feet on the northwest corner of Tract U-a. Within the tracts, the aquifer crops out continuously along the canyon walls throughout the course of Evacuation Creek and further upstream to a point about one mile north of Watson (Figure II-7).

Evacuation Creek

A moderate storm May 5, 1975, left about 2 inches of snow in the region of the tracts; consequently, during this field study snowmelt was the primary source of runoff water in Evacuation Creek. The flow rate of the creek remained fairly constant throughout the study period and is estimated to have been about 1 or 2 second-feet. The suspended mud load of the creek was high and the water extremely murky in the main channel of the creek. In pools adjacent to the creek and along its banks, the streambed was coated by a mud cake 1/16 to 1/2 inch thick.

Water quality information for the creek was obtained by measuring the temperature and conductivity (25°C) at each point shown on Figure II-7. The amount of total dissolved solids in the water can be estimated from these measurements. Water temperature was highly variable, ranging from 9.1 to 22.4°C., depending on air temperature and sun exposure of the creek bank at each measuring point. The main reasons for measuring temperatures were to correct the specific conductance meter measurements to 25°C and aid in differentiating ground water seeps from creek water, which customarily indicates a higher temperature. Values of specific conductance in the creek ranged from 3,600 to 5,400 micromhos per centimeter, roughly equivalent to 2,200 to 3,300 milligrams per liter total dissolved solids (Hem, 1970).*

Hydrologic Interrelationships Between Stream and Aquifer

Recharge to an aquifer will take place where there is a hydraulic gradient toward that aquifer from another water source and where there is hydraulic interconnection, i.e., infiltration of surface water through a soil, streambed, or lake which lies in contact with an aquifer. The rate of recharge is, however, strictly controlled by the permeability of the intervening materials and any barriers to flow will markedly reduce the recharge. Examples of this are evident in many places along Evacuation Creek: the creek was flowing on top of highly permeable sediments that were not receiving enough water from the creek to even saturate the alluvium just a few inches below the streambed. The suspended clay particle load of the stream was serving to effectively seal the pores in the streambed against the downward percolation of the water.

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*U.S. Department of the Interior Geological Survey. Study and Interpretation of the Chemical Characteristics of Natural Water, by J.D. Hem. Water Supply Paper 1473. Washington D.C.: Government Printing Office, 1970.

Discharge of water from the aquifer to the surface takes place in many areas along Evacuation Creek, as evidenced by salt deposits which have accumulated on the aquifer and on the shallow alluvium and soil which overlay the aquifer. During this field study several scattered low flow springs were observed issuing from the bird's nest aquifer along Evacuation Creek (Figure II-7). The most prominent system of seeps and springs were located about 1,500 feet south of Utah State Road 45 bridges in Sec. 13, T.11S., R.24E. Water flowing out of the springs there increased from isolated trickles and moisture spots the first day after the storm to an estimated total discharge of about 50 to 100 gallons per minute two days later. The increased flows were accompanied by sand boils in the alluvium. These phenomena appear to indicate rapid, localized recharge and discharge of the aquifer in the Evacuation Creek area.

In general, the range of specific conductance of the ground water springs was comparable with the range of values measured along the creek: only one very low discharge seep along the east side of the creek, located in the southern third of the map area (Figure II-7), had a relatively low amount of total dissolved solids. Without exception though, the ground water had distinctly different temperature and specific conductance than did the creek water adjacent to each spring's location. Variations in the surface water quality were noticeably influenced by inflow from the different quality of ground water from the bird's nest aquifer.

b. Conclusions

Recharge of the aquifer by infiltration of precipitation into gently sloping aquifer outcrops takes place throughout the majority of Evacuation Creek canyon, mainly before the surface water has reached the actual streambed of Evacuation Creek. This water flows underground primarily through open joints in the aquifer, continues down-gradient along bedding planes, and through somewhat permeable sandstone beds. There are additional localized areas of ground water flow through meander scarps of the creek where water is supplied to the aquifer at higher levels along the creek and flows out of the aquifer near stream level down-gradient on the succeeding meander loop. In those places an equilibrium condition has been established between surface-water inflow and ground water gradient so that springs discharge at or near the creek level.

The bird's nest aquifer is exposed at ground surface throughout the tracts within Evacuation Creek canyon. Even though Evacuation Creek itself probably does not contribute largely to recharge of the aquifer, the entire surface drainage system leading down and across exposures of the aquifer represents a primary recharge area of this aquifer.

4. GROUND WATER LEVEL MONITORING

The results of the monthly water level measurement program are shown in Table II-6. The data span the total period of water level record of wells from the time they were drilled (beginning

TABLE II-6 DEPTH TO WATER IN WELLS - TRACTS Ua-Ub, UINTA COUNTY, UTAH

elevation

WELL NO.	GROUND ELEV. (Feet)	DEPTH TO WATER (FEET) 1974 OCT.	NOV.	DEC.	1975 JAN.	FEB.	MAR.	APR.	MAY	JUNE
P-1	5284	282.5	20/279.8	18/279.8	28/281.0	26/280.8	18/279.19	1/279.7	6/281.0	2/283.8
P-2 (upper)	4991.0				27/104.6	26/101.8	13/99.8	4/100.2	7/99.5	3/99.2
P-2 (lower)	4990.0	160.0	27/159.0	11/158.0 30/158.0	27/157.4	26/157.9	13/155.9	4/157.3	7/157.3	3/157.2
P-3	5486.0	390.0	27/480.0	12/431.0	28/402.1	26/430±		1/489.2		4/499.5
P-4	5718.5	330.0	DRY		1/274.4 13/274.4	27/269.7	26/268.0		6/267.3	2/267.4
G-1	4999.0	DRY	DRY	DRY	MOIST	26/202.2		1/201.8	7/203.3	3/204.1
G-1A*	4998.0	DRY	DRY	DRY	DRY	26/DRY	13/DRY	1/DRY	7/DRY	3/DRY
G-2	5057.0	DRY	DRY	MOIST	DRY	26/124.4		1/124.2	7/123.5	3/125.6
G-2A*	5056.0	DRY	DRY	DRY	DRY	26/DRY	13/DRY	1/DRY	7/DRY	3/DRY
G-3	5260.0	DRY	DRY	DRY	DRY	26/DRY	13/DRY	1/DRY	7/DRY	3/DRY
G-4	5346.5	DRY	DRY	DRY	DRY	26/DRY	13/DRY	1/DRY	7/DRY	3/DRY
G-4A*	5345.5	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
G-5	5292.0	456.0	25/456.0	13/461.0	28/461.6	26/462.0	17/455.6		6/461.0	4/463.0
G-6**	5833.1	47.5		17/140.2	7/168.4	27/168.2	25/171.6		5/168.0	2/171.3
G-7	5498.0	352	15/358.0		24/491.7 28/491.1	26/493.2	14/493.5 26/stuck	1/stuck	11/502.0	4/stuck
G-8	5095.5	49.8	15/53.8 21/49.8	17/54.6 30/54.2	27/54.3	27/54.0	12/53.2 26/53.7		6/53.8	2/53.7
G-8A	5095.0	49.3	21/44.8	10/44.6 30/44.8	27/44.1	27/44.0	12/43.5 26/43.7		6/42.9	2/42.5

II-6 CONTINUED

WELL NO.	GROUND ELEV. (Feet)	DEPTH TO WATER (FEET)								
		1974 OCT.	NOV.	DEC.	1975 JAN.	FEB.	MAR.	APR.	MAY	JUNE
G-10	5364.0	312.5	15/315.1 22/314.6	13/319.5	28/319.9	26/319.6	14/312.6		6/312.3	4/312.2
G-11	5375.0	485	25/485.5	13/482.3	28/478.8	26/478.2	14/471.0		6/475.2	4/475.0
G-12	5314.0	45.1	25/40.8	17/46.1 30/46.5	27/46.9	27/47.1	25/38.4		6/33.2	2/31.9
G-13**	5360.6	11.9	21/9.7	10/9.6 30/9.8	27/9.9	27/9.6	12/9.8 25/9.7	7/10.0	6/9.6	2/9.6
G-13A	5360.6	12.3		30/10.2	2/9.6 27/10.4	27/10.1	25/10.2	7/10.1	6/10.1	2/10.0
G-14	5172.0	41.4	15/40.2 21/42.2	10/40.3 30/40.6	27/40.6	27/41.1	12/39.5 26/38.6	9/38.6	9/38.6	2/38.8
G-15	5343.0	513.8	16/511 23/513.8	11/510.4	28/510.7	26/511.1	14/504.1	1/510.9	7/514.8	3/510.8
G-16**	5532.7	28.5	26/28.6	10/28.5 30/28.6	28/28.5	27/28.5	11/28.4 26/28.9	8/28.9	5/28.9	2/28.9
G-16A*	5532.1	Flo 5.0gpm	Flo	Flo	Flo	Flo 2.35gpm	11/Flo 1.8gpm	Flo	5/Flo 1.7gpm	2/Flo 1.7gpm
G-16B*	5532.8	DRY	DRY	DRY	DRY	27/DRY	26/DRY	8/DRY	5/DRY	2/DRY
G-17***	5174.0	DRY	ACCUM. WATER	17/79.0 30/76.4	27/71.2	27/68.6	18/66.8 26/82.1		5/74.7	
G-18	5170.0	DRY		30/62.6	27/63.2	27/61.7	26/61.0		9/33.6	2/33.6
G-18A*	5171.5	DRY		30/DRY	2/DRY	27/DRY	24/25.0 26/27.2	7/19.1	9/22.4	2/19.9
G-19	5832.1	DRY	DRY	DRY	DRY	7/800.0 27/798.4	25/798±		5/799.7	2/799±
G-20	5362±	11.4	15/9.9 26/8.6	10/8.7 20/9.1	27/9.3	27/8.7	12/8.8 25/8.6		6/8.6	2/8.6
G-21	5262.0	428.7	30/430.0	12/430.0	27/577.8	26/431.6		1/430.8	7/433.2	3/435.1
G-22	5387.5	491		DRY	28/504.0	26/503.8		1/HUMID	6/HUMID	4/505.0

II-6 CONTINUED

WELL NO.	GROUND ELEV. (Feet)	DEPTH TO WATER (FEET)								
		1974 OCT.	NOV.	DEC.	1975 JAN.	FEB.	MAR.	APR.	MAY	JUNE
X-1	5293.5				3/578.2	16/444.0		1/395.4	7/443.8	3/440±
X-2	4984.0				3/199.2 17/53.0	26/50.7	26/51.2		6/51.0	3/49.3
X-3	5295.0					27/TAR	26/TAR	1/TAR	7/TAR	2/TAR
X-4	5242.5				18/335	26/TAR	26/TAR	1/TAR	6/TAR	4/TAR
X-5	5381.5				17/322	26/324.2		1/312.0	6/312± HUMID	4/312± Cascading
X-6	5472.0				18/337	27/TAR	26/TAR	1/TAR	6/TAR	2/Lock Stuck
X-9	5427.0				13/597	26/593.8		1/508.8	7/513.3	3/528.5
X-10	5463.5				14/632	26/6320		1/631.3	7/634.0	3/633± TAR
X-11	5261.0				15/410	26/426.4		1/171.6 HUMID	7/360± HUMID	3/376± HUMID

*Alluvial Well

**Birds Nest Aquifer dry or absent

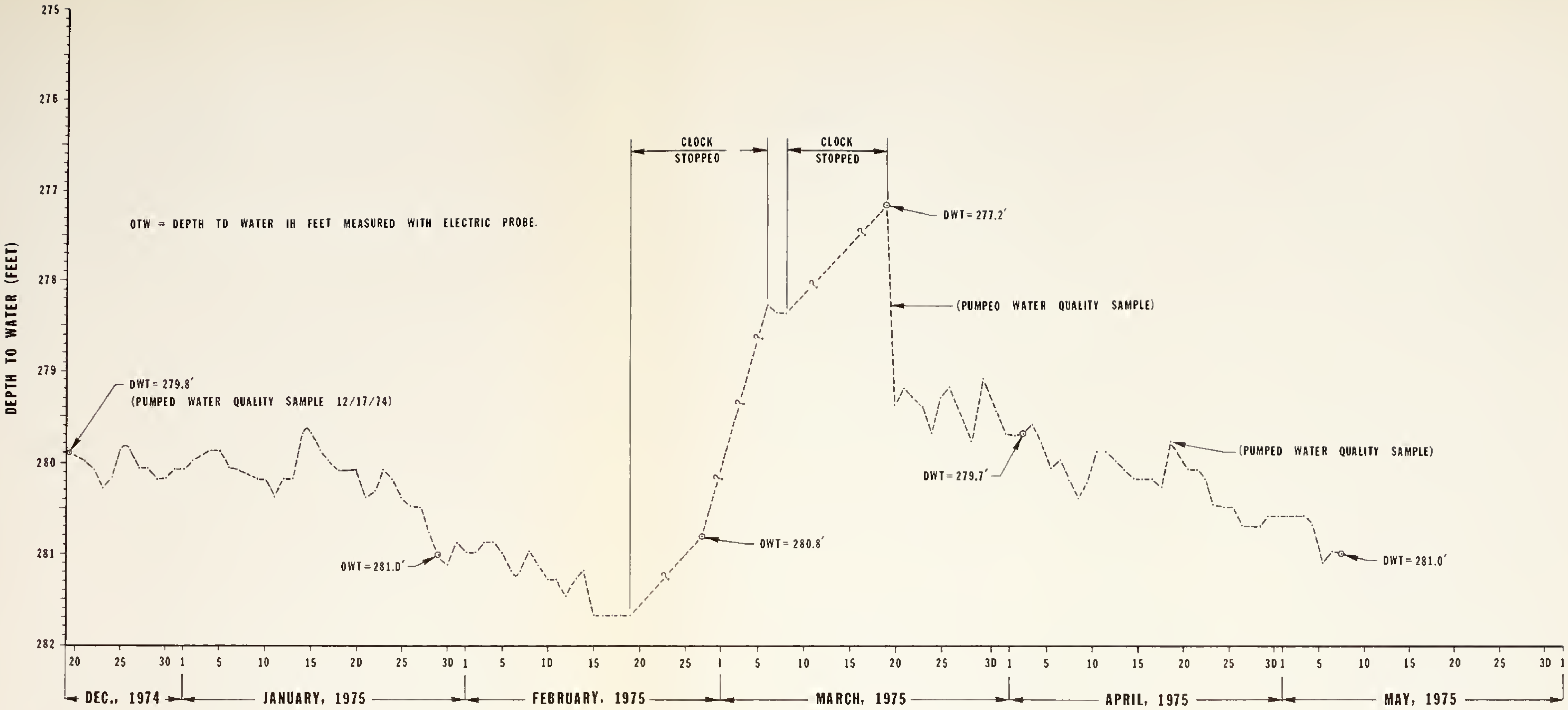
***Well completed above Birds Nest. May be receiving upward leakage.

in October 1974) through June 1975. Some wells contain very high humidity and accurate measurements are not always obtainable (e.g., P-3, G-22, X-11), and some of the X-holes have accumulated a layer of tar on their water surface and accurate measurements are not possible. These conditions account for the wide disparity in water level data tabulated for these holes. The depths to water in those holes which present no problems to accurate measurement suggest that water levels do not fluctuate widely over the period of record. The records also suggest that generally the highest water levels recorded were in March 1975. Ground water elevations which are monitored continuously in the P-wells, are shown on Figures II-8 through II-11.

Figures II-12 and II-13 are quarterly ground water elevations maps through the tracts. The contour patterns are different because the March 1975 map includes drill holes completed subsequent to November 1974.

5. GROUND WATER QUALITY

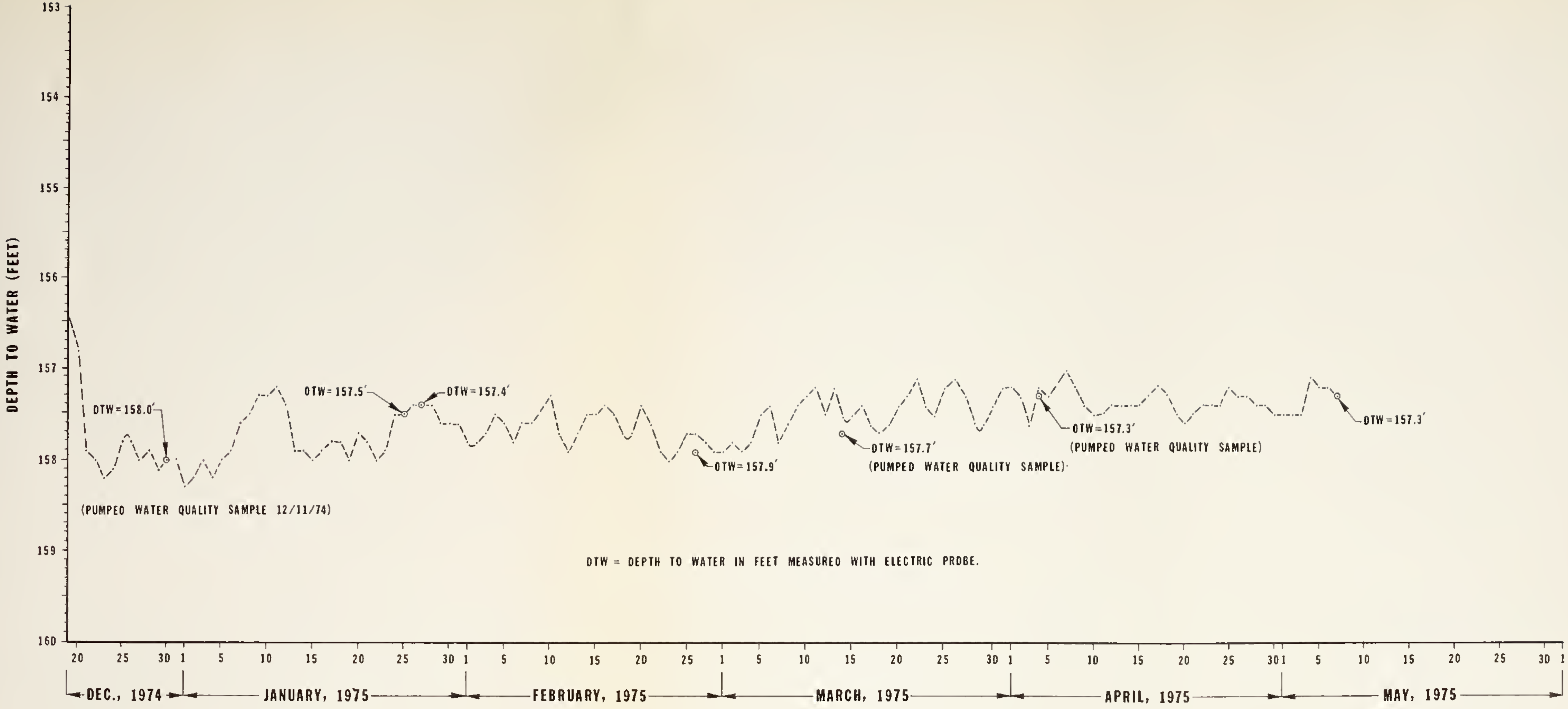
Figure II-14 illustrates the Stiff diagrams of water quality and compares the quality of water collected in December 1974 and March 1975. The samples were collected by pumping the wells for 30 or 45 minutes prior to sampling unless otherwise indicated as having been "thief" sampled. Thieving is accomplished by lowering a collecting device below the water level, closing it from the surface, and retrieving the water sample. Samples collected in this manner and pumped samples exhibit significant differences in their respective water qualities, as shown by the Stiff diagrams



CONTINUOUS MONITORING WELL
P-1

(SURFACE ELEVATION = 5284.0 FT.)

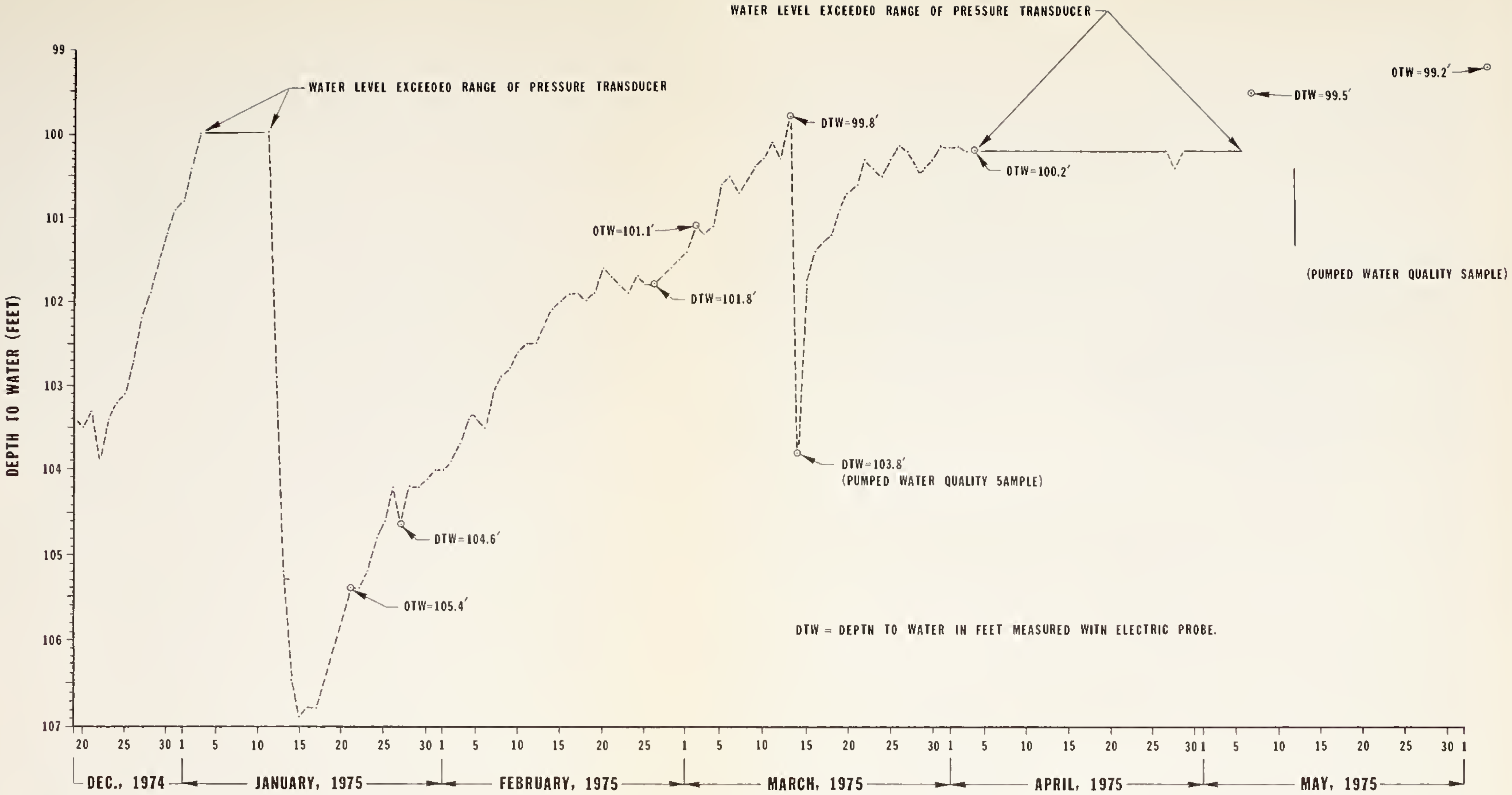
FIGURE II-8



CONTINUOUS MONITORING WELL
P-2 LOWER

(SURFACE ELEVATION = 4991.0 FT.)

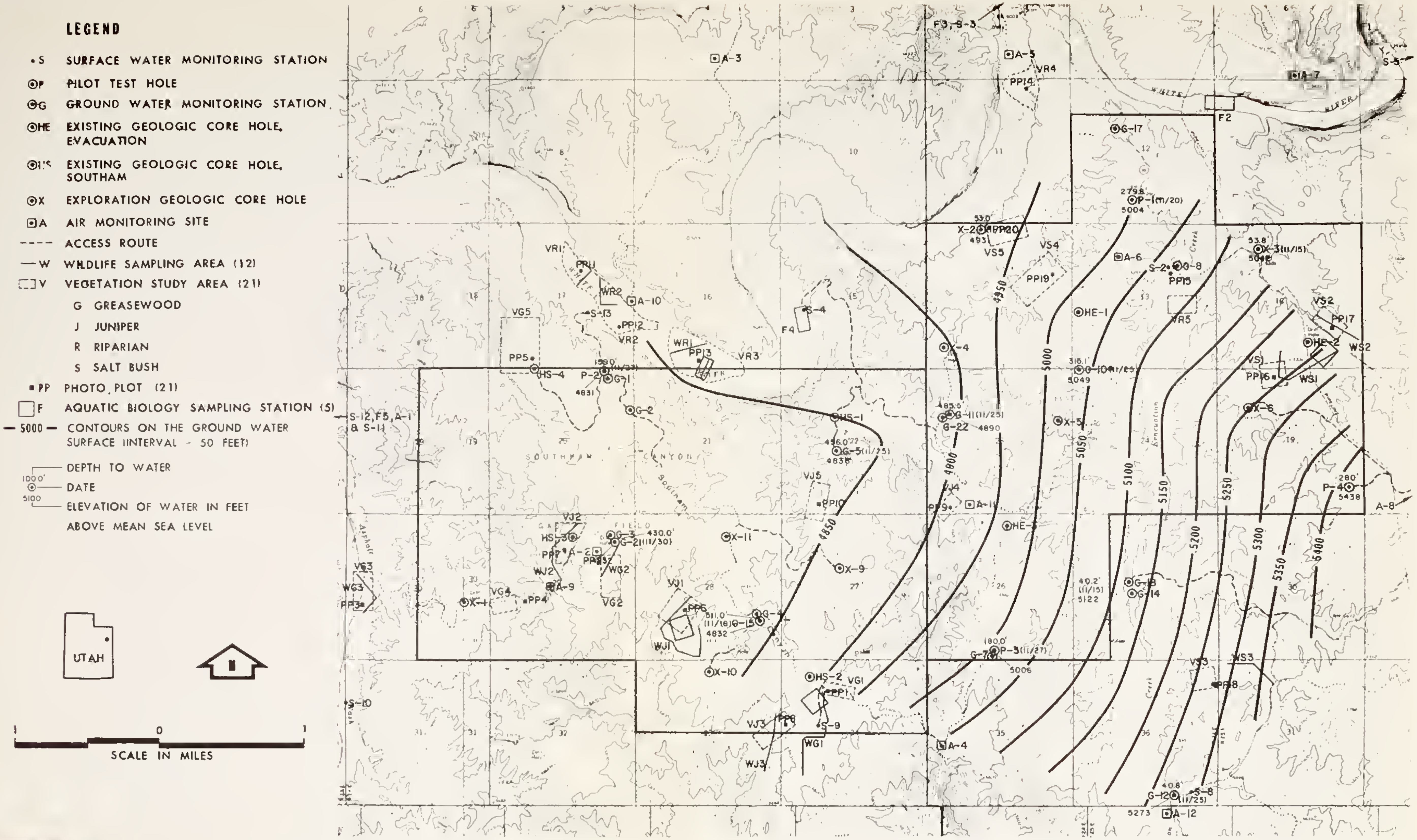
FIGURE II-10



CONTINUOUS MONITORING WELL
P-2 UPPER

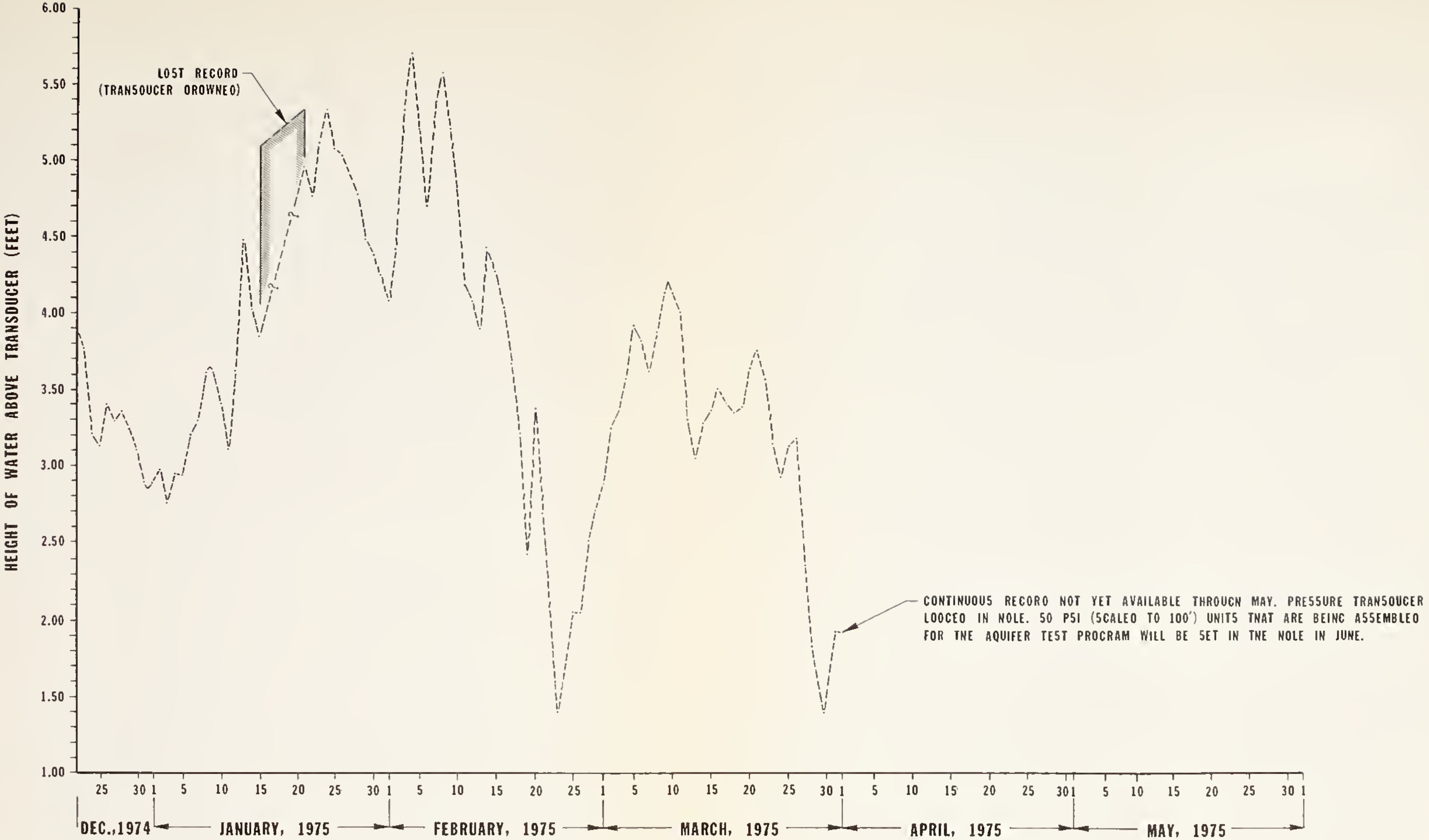
(SURFACE ELEVATION = 4991.0 FT.)

FIGURE II-9


LEGEND
•S SURFACE WATER MONITORING STATION
⊙P PILOT TEST HOLE
⊙G GROUND WATER MONITORING STATION
⊙HE EXISTING GEOLOGIC CORE HOLE, EVACUATION
⊙HS EXISTING GEOLOGIC CORE HOLE, SOUTHAM
⊙X EXPLORATION GEOLOGIC CORE HOLE
⊡A AIR MONITORING SITE
---- ACCESS ROUTE
—W WILDLIFE SAMPLING AREA (12)
[ ]V VEGETATION STUDY AREA (21)
G GREASEWOOD
J JUNIPER
R RIPARIAN
S SALT BUSH
▪PP PHOTO PLOT (21)
□F AQUATIC BIOLOGY SAMPLING STATION (5)
—5000— CONTOURS ON THE GROUND WATER SURFACE (INTERVAL - 50 FEET)
100.0' DEPTH TO WATER
DATE
5100 ELEVATION OF WATER IN FEET ABOVE MEAN SEA LEVEL
UTAH
1 0 1
SCALE IN MILES
4850
4900
4950
5000
5050
5100
5150
5200
5250
5300
5350
5400
WHITE RIVER
SOUTHAM CANYON
GAS FIELD

CONTOURS ON THE GROUND WATER SURFACE OF THE BIRDS NEST AQUIFER, NOVEMBER, 1974

FIGURE II-12



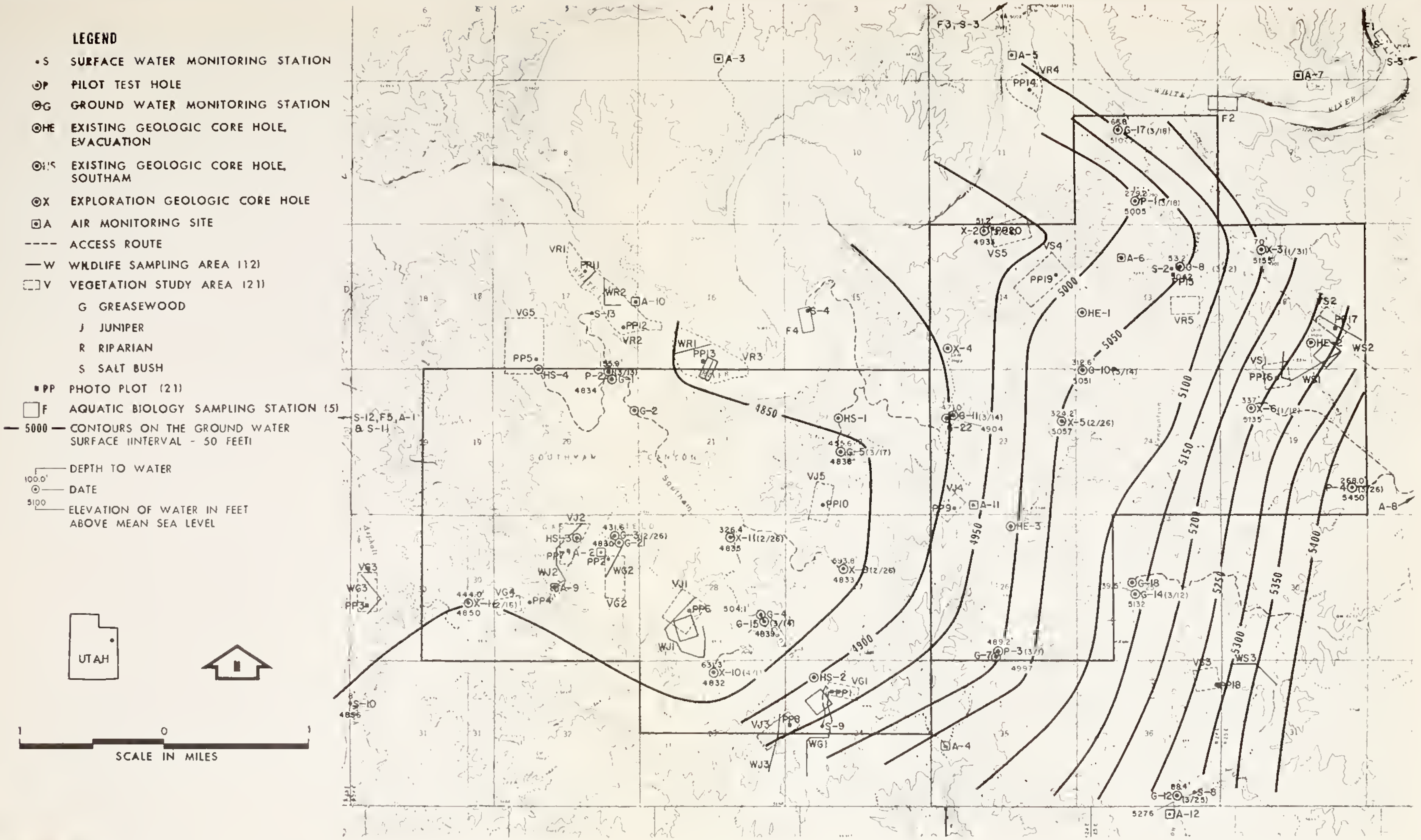
LOST RECORD
(TRANSDUCER DROWNED)

CONTINUOUS RECORD NOT YET AVAILABLE THROUGH MAY. PRESSURE TRANSDUCER LODGED IN HOLE. 50 PSI (SCALED TO 100') UNITS THAT ARE BEING ASSEMBLED FOR THE AQUIFER TEST PROGRAM WILL BE SET IN THE HOLE IN JUNE.

CONTINUOUS MONITORING WELL
G-7

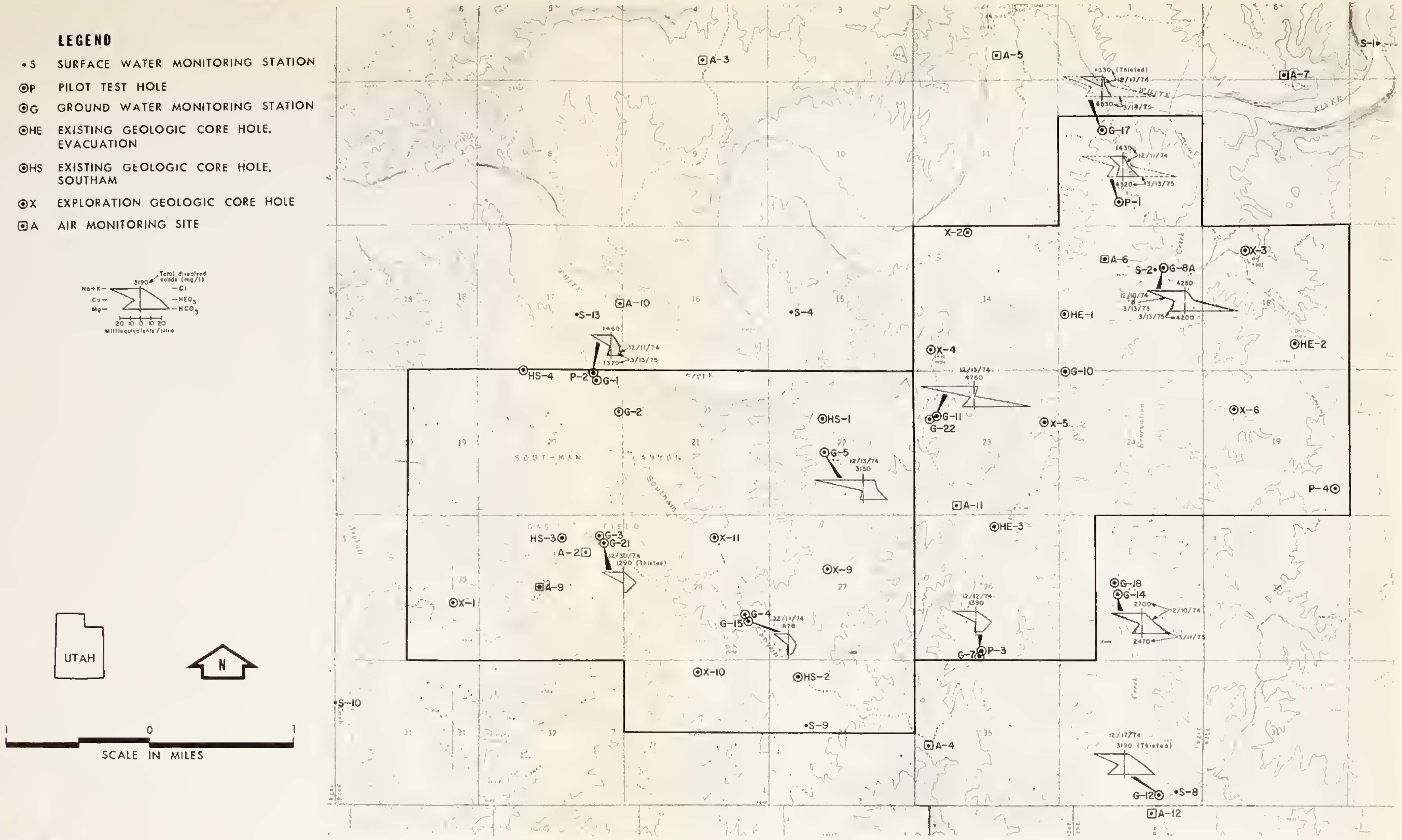
(P-3 SITE)

FIGURE II-11



CONTOURS ON THE GROUND WATER SURFACE OF THE BIRDS NEST AQUIFER, MARCH, 1975

FIGURE II-13



LEGEND

- •S SURFACE WATER MONITORING STATION
- ⊙P PILOT TEST HOLE
- ⊙G GROUND WATER MONITORING STATION
- ⊙HE EXISTING GEOLOGIC CORE HOLE, EVACUATION
- ⊙HS EXISTING GEOLOGIC CORE HOLE, SOUTHAM
- ⊙X EXPLORATION GEOLOGIC CORE HOLE
- ⊡A AIR MONITORING SITE

WHITE RIVER SHALE PROJECT

STIFF DIAGRAMS OF WATER QUALITY

DECEMBER, 1974 AND MARCH, 1975

EASTERN UINTA BASIN, UTAH

FIGURE II-14

(Well P-1). Apparently, the ground water standing in the wells exposed to the air and well casing undergoes significant quality changes in concentrations of the elements used to construct the diagrams.

Pumped ground water samples were collected in March from all bedrock and alluvial monitoring wells which contained water, and in April and May from the following selected wells:

P-1
P-2 upper and lower
P-3
P-4
G-5
G-11
G-15
G-21

This group of wells was selected because of their location in an area of gas production where water quality differences are known to exist. This area of gas and water quality anomaly could be separated along a northwest-trending line roughly coincident with the dominant direction of fracturing.

The lab analyses for the April and May samples are not available at this time.

C. WORK SCHEDULED

1. SURFACE WATER

Precipitation, evaporation, and stream discharge recordings will continue as stated in the Conditions of Approval and the Partial Exploration Plan. In the next quarter, a preliminary surface hydrologic model will be constructed to simulate the surface hydrology of the tracts. Stream flow hydrographs will be generated from the collected hydrologic data to quantitatively determine the interrelationships between precipitation, runoff, and stream flow. The model will incorporate meteorological, biological, and pedological information where deemed necessary to evaluate the surface hydrological processes.

2. SURFACE WATER QUALITY

Sediment and chemical sampling will be performed as specified in the agreements made between VTN, AOSS, and USGS.

The next quarterly report will summarize analyses of these constituents using variance, standard deviations, normal geometric means, and hypothesis tests.

3. GROUND WATER

The 30-day public notice period will end June 27, 1975, on the discharge applications (aquifer tests) submitted to the EPA in May. We expect to receive the permits in the first two weeks of July.

4. GROUND WATER LEVEL MONITORING

The monthly electric probe water level measurements will continue through the next quarter. The installation of the 50 psi pressure transducers is expected to eliminate some of the problems encountered with the 5 psi units. The selected group of wells will be radioactively logged in July as part of the moisture monitoring program. These will constitute the third logging effort.

5. GROUND WATER QUALITY

A letter will be submitted to the AOSS requesting that monthly pumped sampling be suspended during the aquifer test period and that quality sampling be done from the pumping well only as designated in the lease stipulations, Conditions of Approval, and EPA discharge permits. This is deemed necessary to eliminate undue stresses on the aquifer system during testing.

III. AIR RESOURCES

A. WORK COMPLETED

During the quarter ending May 31, 1975, all of the meteorology, air quality, radiation, and sound level monitoring activities were performed as stipulated in the provisions of the lease or prescribed by the Conditions of Approval for the environmental baseline monitoring program. Certain additional supporting measurements were also made at the request of the lease operators.

By the end of the quarter, commercial electric power had been connected to all of the aerometric monitoring trailer sites with the exception of Station A-5. Aesthetic considerations precluded installation of a power line to this site, so it will continue to be powered by a propane generator with a backup unit.

The first sound level survey was conducted on the tracts during April after most of the noise interference from propane generators had been eliminated. Similar surveys will be repeated quarterly.

Sigma meters and vertical anemometers were installed in April at the tops of the towers at Stations A-2, A-4, and A-6 for continuous recording of vertical diffusion. These installations will supplement the previous lateral diffusion instrumentation and the bistatic acoustic sounder at Station A-6 to provide a more comprehensive picture of low level diffusion parameters.

Low reliability of gas chromatographic instrumentation continued. Modification of the hydrogen supply system to the hydrocarbon analyzers should decrease future recurrences of these problems. The manufacturers are investigating methods of improving the reliability of the sulfur detection instruments.

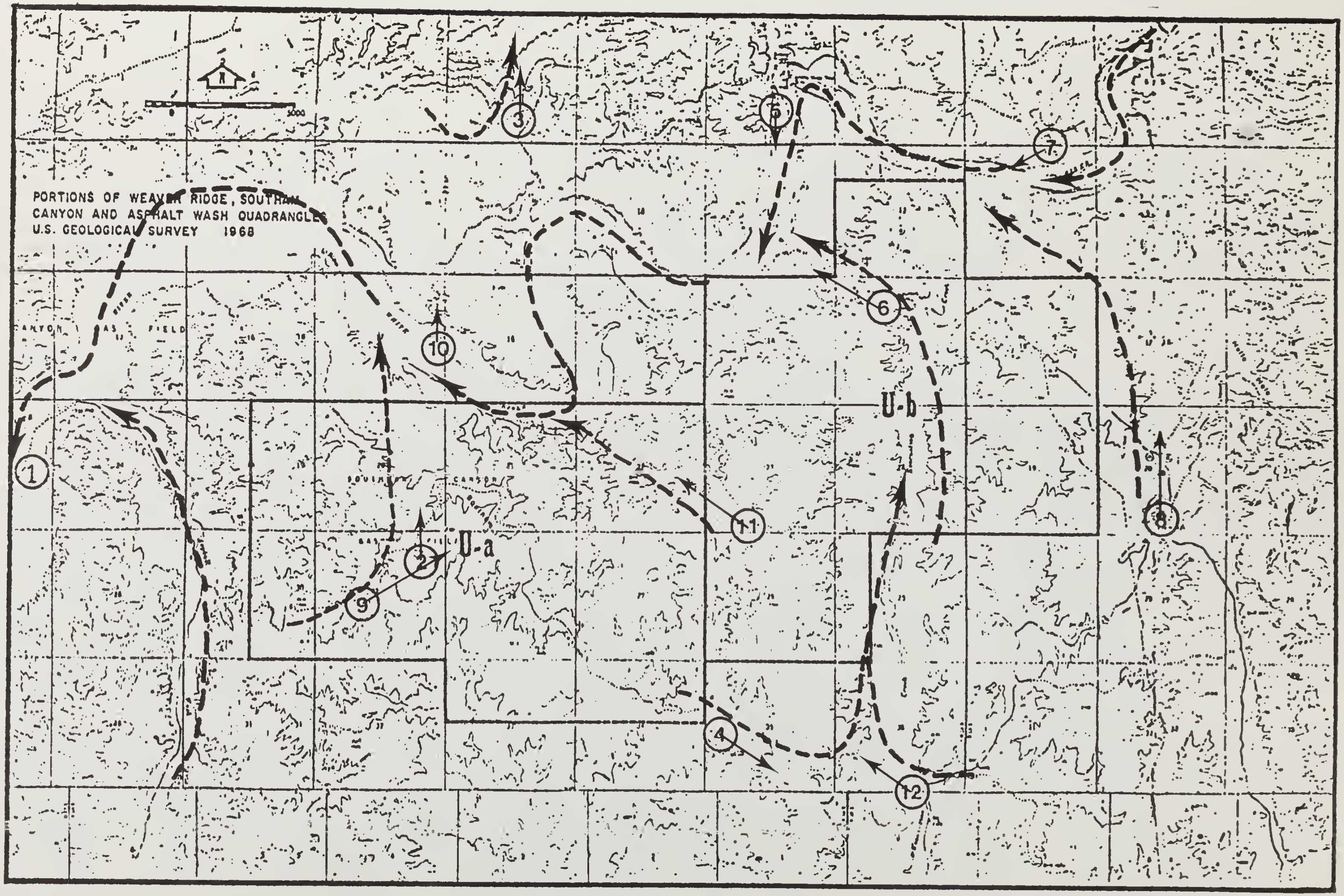
B. DATA SUMMARY

Air resources data from this quarter were analyzed by Aerovironment and are presented below. The results have been correlated with comparable information from previous quarters and from previous years where possible. In addition, results are now available for extended laboratory analyses for trace metals and radioactivity in samples collected in previous quarters and for the February diffusion experiment.

1. METEOROLOGY

a. Surface Meteorology

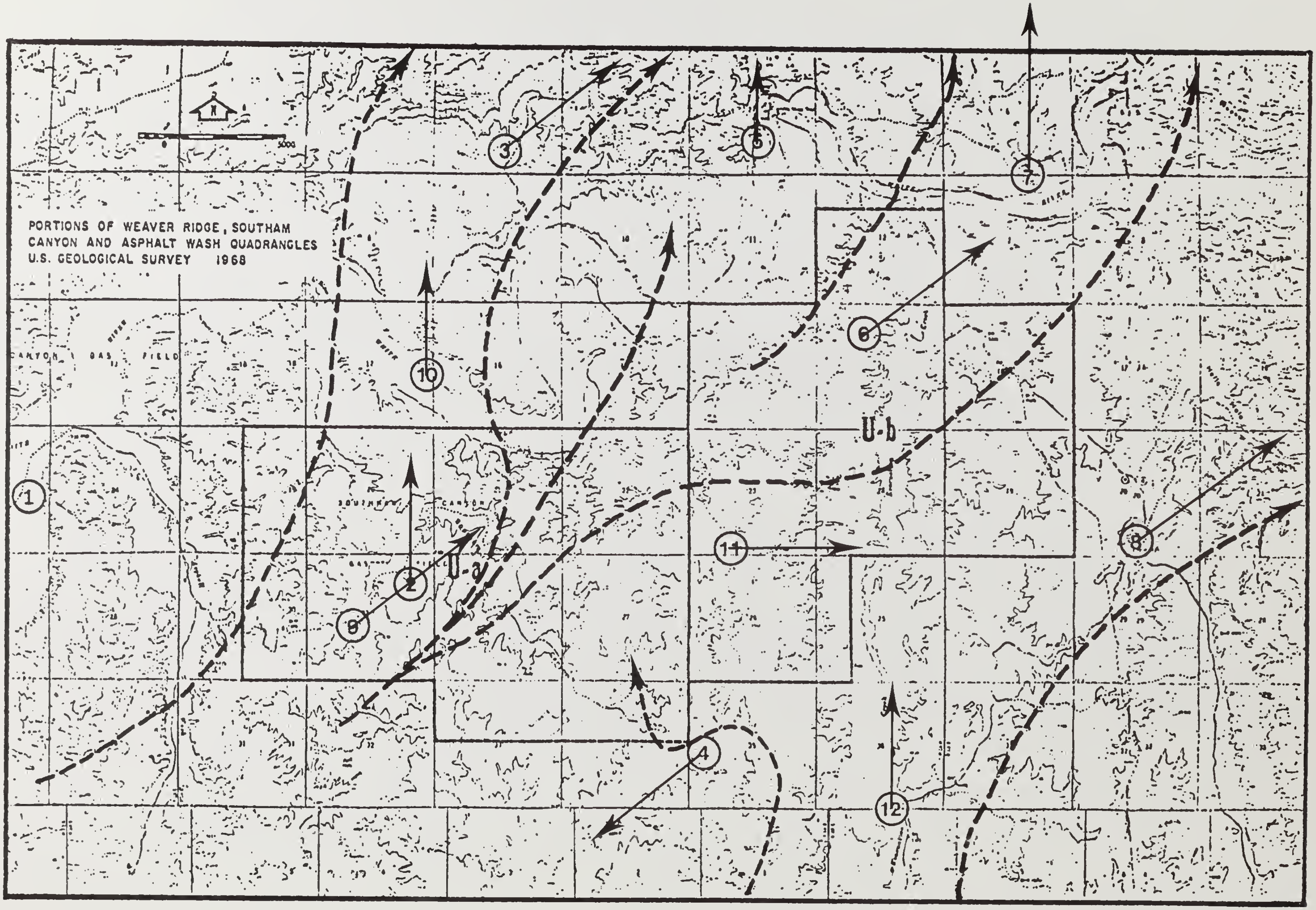
The surface airflow pattern on the tracts was again complicated by terrain effects. For example, typical early morning (0400-0700 MST) and afternoon (1400-1600 MST) airflows in April are plotted in Figures III-1 and III-2. Solid arrows depict wind vectors, as observed at monitoring sites, and the dotted lines depict probable streamlines. During the early morning hours, drainage flows dominated: flow was toward low terrain and along the White River. In the afternoon, winds were stronger and an amost organized southwesterly flow emerged. The total airflow pattern was still strongly topographically influenced, particularly as shown by wind vectors at Stations A-2, A-4, and A-9.


PORTIONS OF WEAVER RIDGE, SOUTHAM CANYON AND ASPHALT WASH QUADRANGLES
U.S. GEOLOGICAL SURVEY 1968
N
2000
CANYON
GAS FIELD
U-a
U-b
1
2
3
4
5
6
7
8
9
10
11
12

5 mps ⟶ wind velocity at monitoring site

- - - - - - - → streamlines

FIGURE III-1. Typical airflow pattern on the tracts Ua and Ub in morning in April, 1975.


PORTIONS OF WEAVER RIDGE, SOUTHAM
CANYON AND ASPHALT WASH QUADRANGLES
U.S. GEOLOGICAL SURVEY 1968
N
0
5000
CANYON GAS FIELD
SOUTHAM CANYON
U-a
U-b
1
2
3
4
5
6
7
8
9
10
11
12

5 mps → wind velocity at monitoring site

-------→ streamlines

FIGURE III-2. Typical airflow pattern on tracts Ua and Ub in the afternoon in April, 1975.

Average wind strength increased in the last quarter (March-May) over that of the quarter before (December-February). For comparison, Figure III-3 shows the diurnal variation of the mean wind speed and its standard deviation in January and April at Station A-6.

These data show that the average wind speed during the afternoon was generally higher in April than in January. This is especially true at 1600-1700 MST when the average wind speed was about 5 m/s (10 mph) higher in April than in January. The relative percentage frequency distribution of wind speed at this site in January and April is presented in Table III-1, which shows that wind speeds were less than or equal to 2.6 m/s (6 mph) 78 percent of the time in January and 37 percent of the time in April. Also, the wind speed exceeded 8 m/s (18 mph) less than 2 percent of the time in January and 14 percent of the time in April. During these two quarters, low winds were usually observed at night, especially between 0600-0900 MST, and strong winds were observed between 1200-1500 MST in January and between 1200-1700 MST in April.

The diurnal variation in temperature in January and April at Station A-6 is shown in Figure III-4. There is a strong similarity in the diurnal patterns and in the magnitude of the diurnal differences. All values of the average temperature are generally about 10°C higher in April than in January. During both months the daily maximum temperature was observed between 1400 and 1500 MST and the daily minimum temperature was observed at 0500-0600

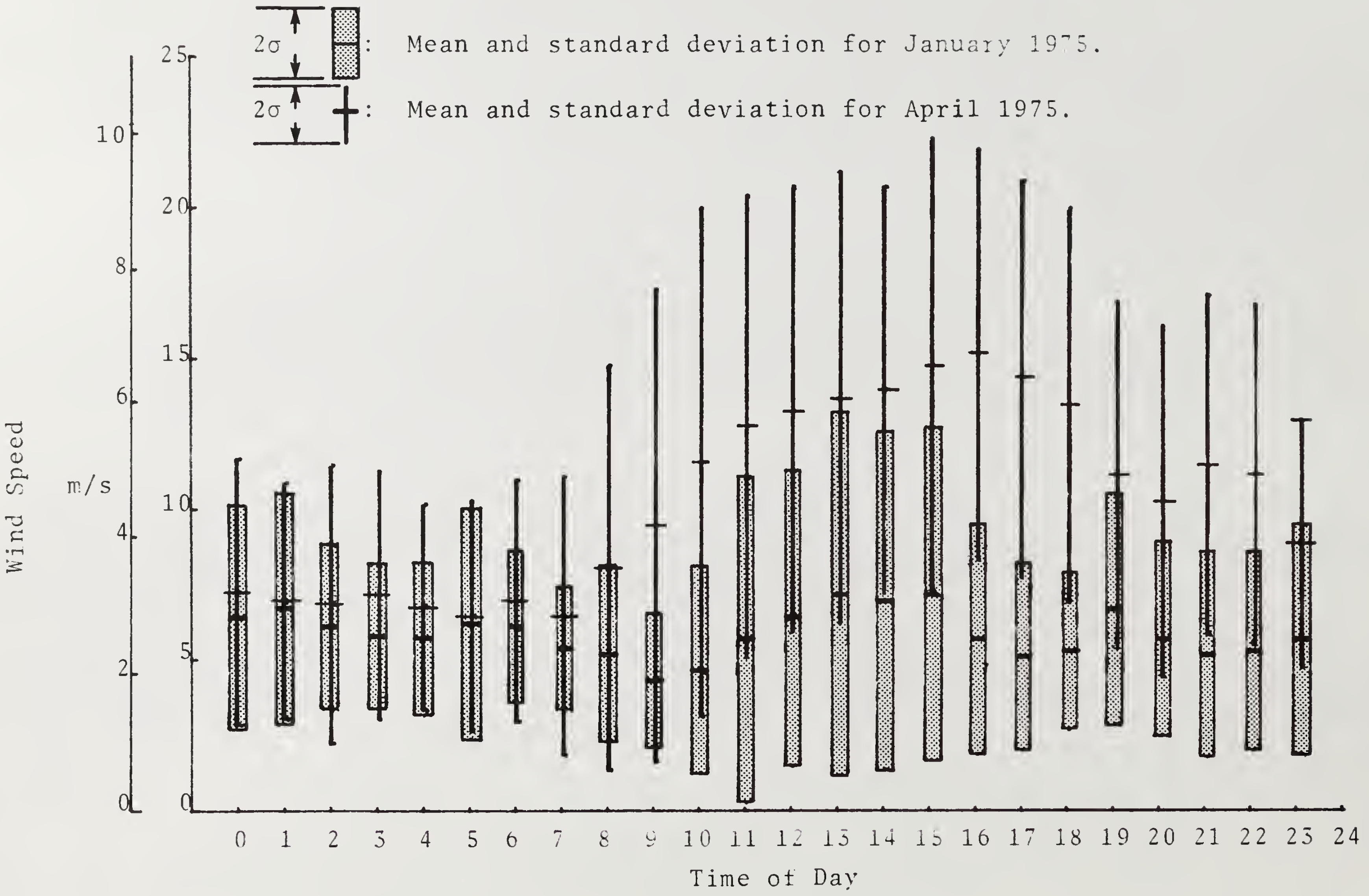


FIGURE III-3. Diurnal variation of mean wind speed at Site 6 in January and April, 1975.

TABLE III-1. Percentage frequency distribution of wind speed at site A6 in January and April, 1975.

Wind Speed	m/s	0-1.3	1.4-2.6	2.7-5.3	5.4-8.0	8.1-11.1	11.2-15.6	> 15.6
	mph	0-3.0	3.1-6.0	6.0-12.0	12.2-18.0	18.1-25.0	25.1-35.0	> 35.0
January		28.1	51.3	13.2	5.8	1.6	0	0
April		14.4	22.8	31.7	16.1	13.0	1.6	0.1

Entries in boxes indicate percentage of hours wind speeds were within the ranges indicated during the given months.

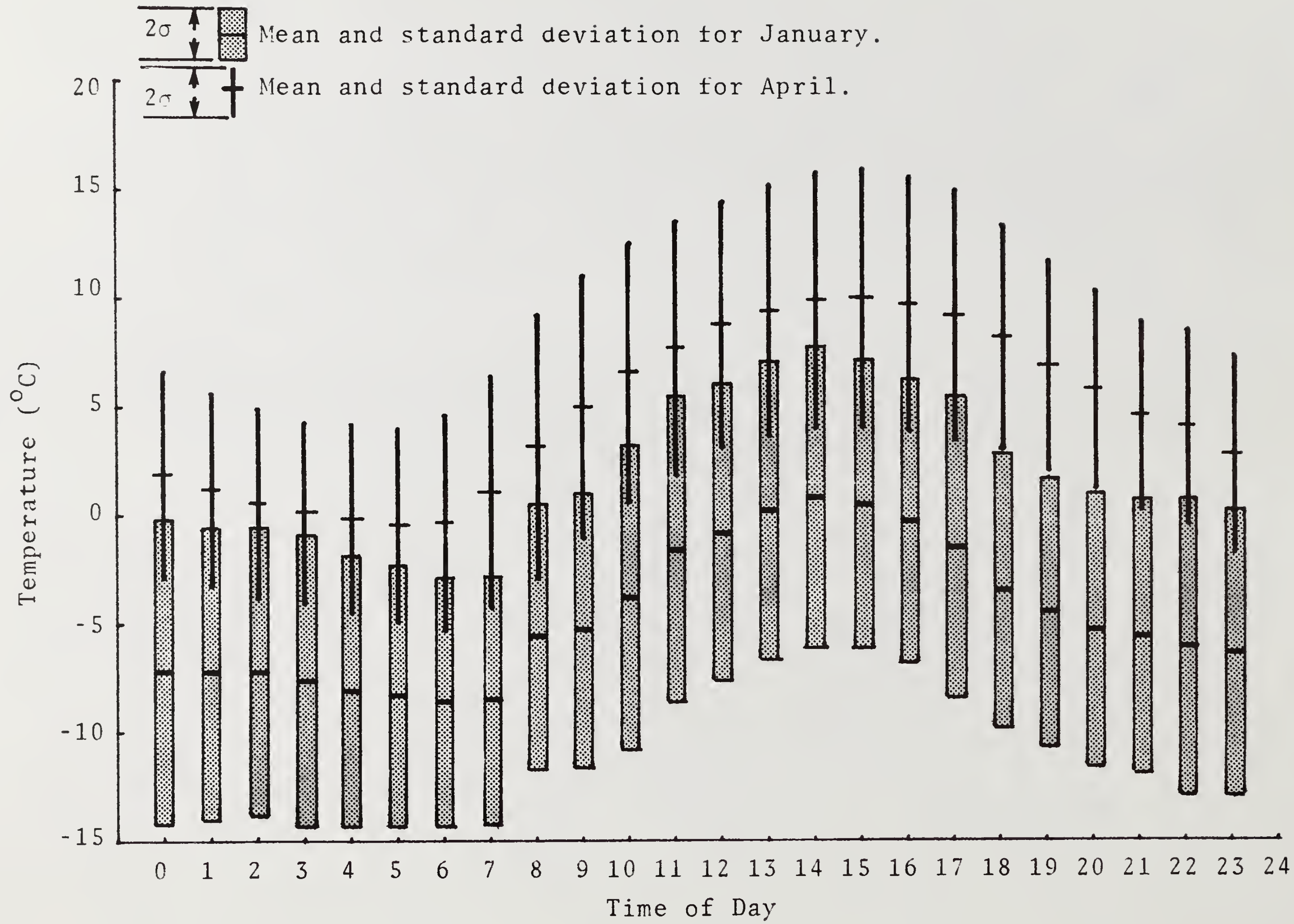


FIGURE III-4. The diurnal variation in mean temperature and its standard deviation at A6 in January and April, 1975.

MST. April 25 the maximum temperature at Station A-6 was 20°C at 1400 MST and April 2 the minimum temperature was -15°C at 0600 MST.

b. Upper Air Meteorology

Rawinsonde probing of upper air temperature, relative humidity, and wind on the tracts occurs twice daily every sixth day, with one release in the morning at dawn and one in the early afternoon. Continuous acoustic sounding is conducted for the bottom kilometer (.62 miles) of the atmosphere at the rawinsonde release location (Station A-6).

For 1975 through the end of this reporting period, a surface-based inversion generally occurred in the morning, attributable to nocturnal cooling of the earth's surface, and generally disappeared in the afternoon. The average thickness of the inversion decreased from about 223 m in February to 94 m in April. The strength of the inversion was about 2°C/100 m, varying from 0.2°C/100 m to 4.2°C/100 m in February and from 1°C/100 m to 2.4°C/100 m in April.

Early morning upper air or subsidence inversions were common in February. Quite a few of these upper air inversions lasted into the afternoon, although both thickness and strength decreased. In contrast, in April an upper air inversion was observed only once in the morning and never in the afternoon.

Relative humidity in the lower kilometer above the ground was about 70 percent in the morning and about 50 percent in the afternoon. There was no significant change from February to

April. Winds in the first kilometer above the ground were quite variable from day to day. Above 1 kilometer the winds were usually from the west with an average speed of about 8 m/s.

Figures III-5 and III-6 are graphs of rawinsonde soundings on a typical day (March 19). They indicate a stable layer in the morning and an almost neutral temperature lapse rate in the afternoon. The morning surface-based inversion was about 300 m thick with a strength of 2°C/100 m. Lower level winds were from the southwest in the morning and from the west in the afternoon; upper-level winds were from the west in the morning and from the southwest in the afternoon. Wind speed was about 2 m/s throughout the lower two kilometers in the morning and increased with height with a maximum of 10 m/s at 2,200 m above ground (3,800 m, or 12,500 ft, above sea level).

c. Normality of Measurement Period

Comparison of certain meteorological parameters with their historical norm will determine the representativeness of this study period. Owing to the lack of historical meteorological data on the tracts, the test of whether or not the meteorological conditions in the period of measurements was normal was performed on the rawinsonde data collected by the National Weather Service at Grand Junction, the closest upper air monitoring station. Although this station is removed from the tract area, such a test is still a valid indication of the normality of the synoptic scale characteristics of the meteorology for this period. Average wind speed, temperature, and humidity readings over ten years

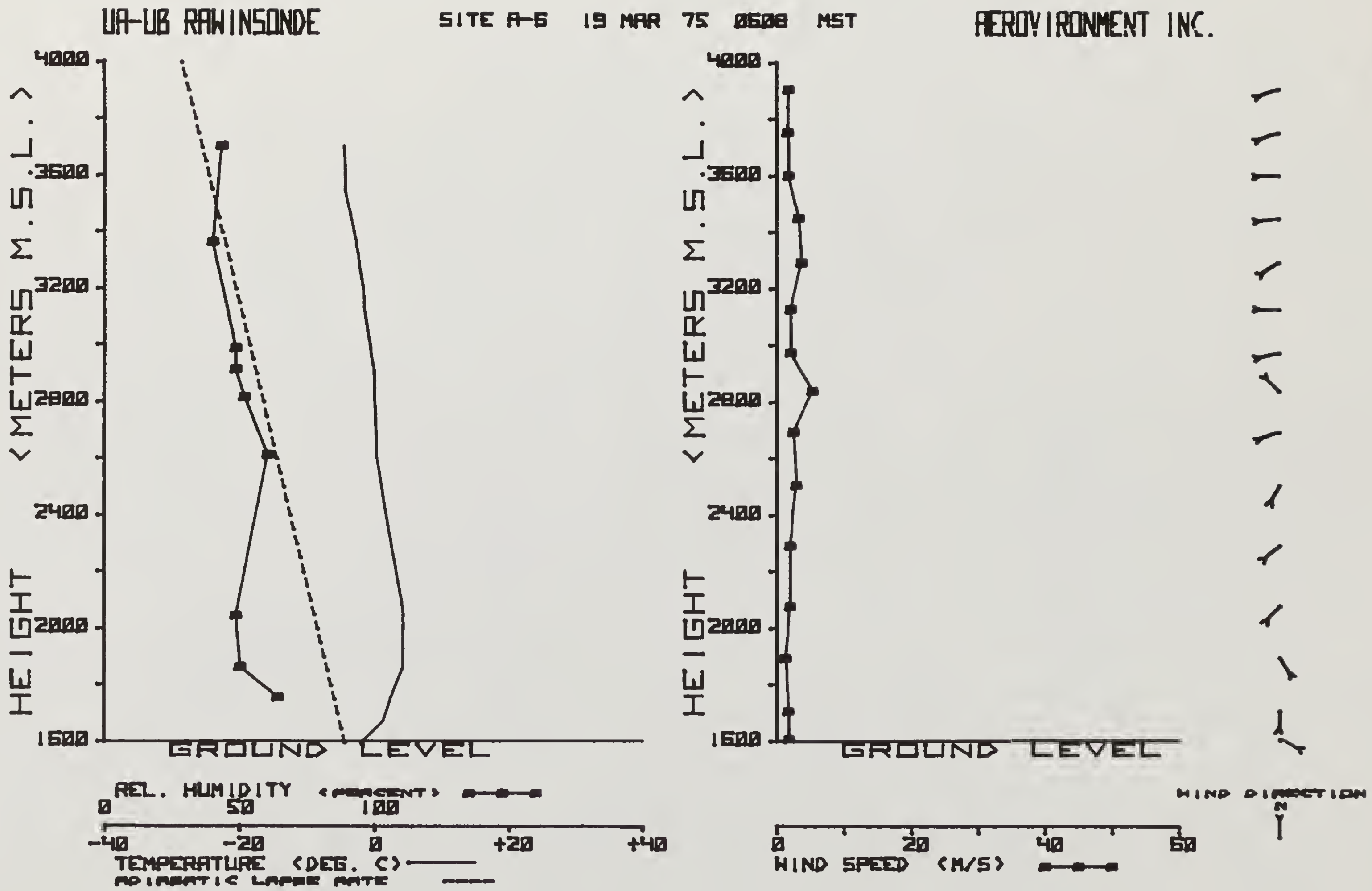


FIGURE III-5. Rawinsonde sounding taken over A6 at 0600 MST on 19 March 1975.

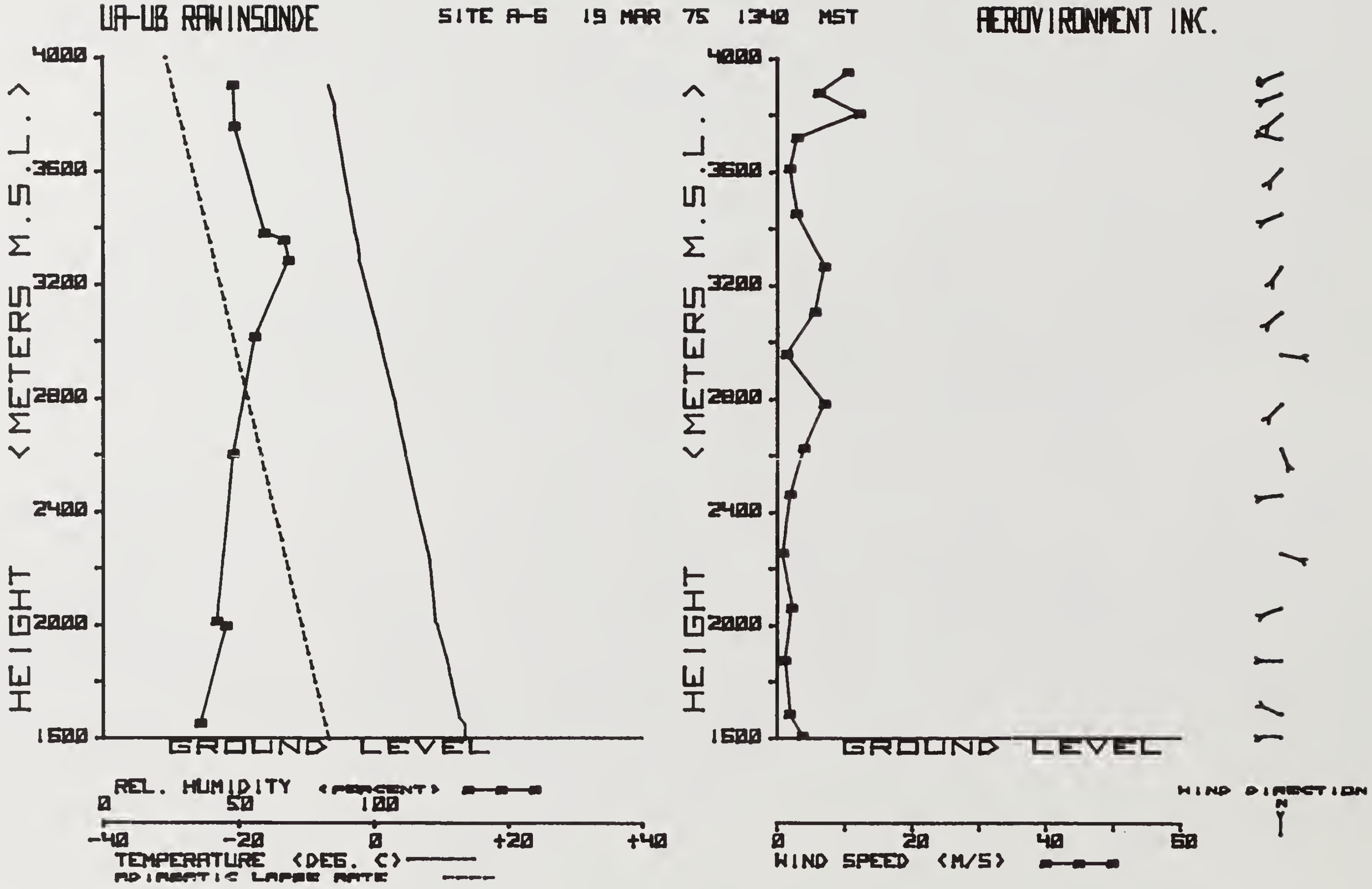


FIGURE III-6. Rawinsonde sounding taken over A6 at 1340 MST on 19 March 1975.

were calculated. These averages were obtained for standard significant pressure levels at 850 millibars (mb) (approximately at the surface in Grand Junction), 700 mb (about 3,000 m or 10,000 ft mean sea level), and 500 mb (about 5,600 m or 18,300 ft) at 1700 MST and 0500 MST. Since it takes half a year of processing time before upper air data collected at Grand Junction becomes available to the public. Only data for November and December, 1974 has been analyzed, which correspond to the first two months of air quality and meteorological measurements taken on the tracts. These data were compared with averages for the same months in 1964 through 1973.

Figure III-7 shows comparison of November and December average wind speeds at 1700 MST at significant pressure levels with their ten-year averages. Figure III-8 shows a similar comparison of average wind speeds at 0500 MST, and Figures III-9 through III-12 present similar comparisons for humidity and temperature. These comparisons show that during the measurement period, average wind speeds at 500 mb were lower than were the average wind speeds in the ten-year period. In November the speed was about 2 m/s lower, and in December it was about 5 m/s lower. Similar though smaller differences existed at the lower levels. The relative humidity at the surface during 12Z (0500 MST) soundings in November was about 20 percent above the norm; it was about 10 percent below normal during 00Z soundings in December. Other meteorological parameters under investigation showed comparable values to those of ten-year averages; thus, except for a higher than normal relative humidity at the surface during November,

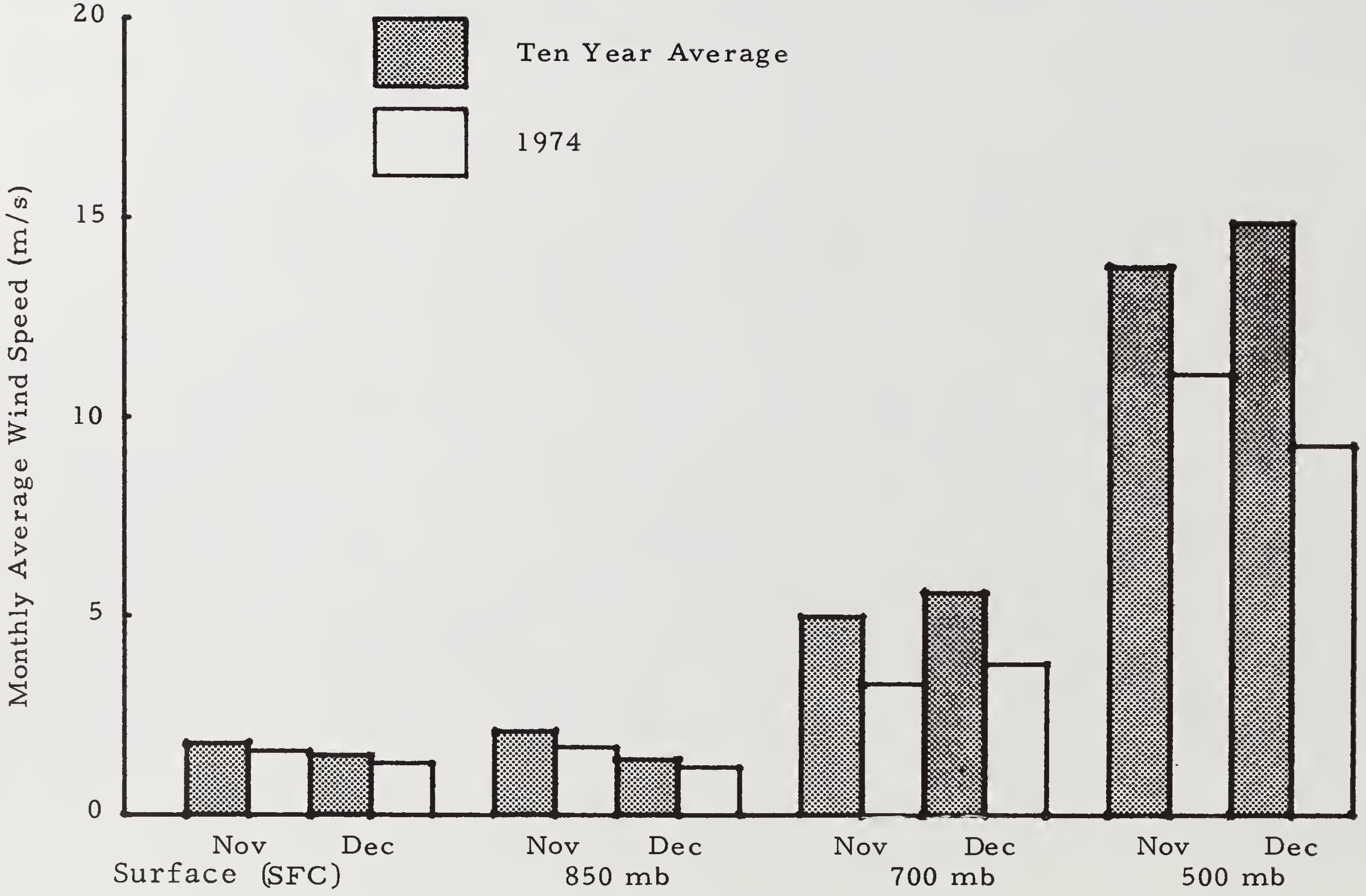


FIGURE III-7. Normality of 00Z Grand Junction rawinsonde wind speed observations for November and December 1974.

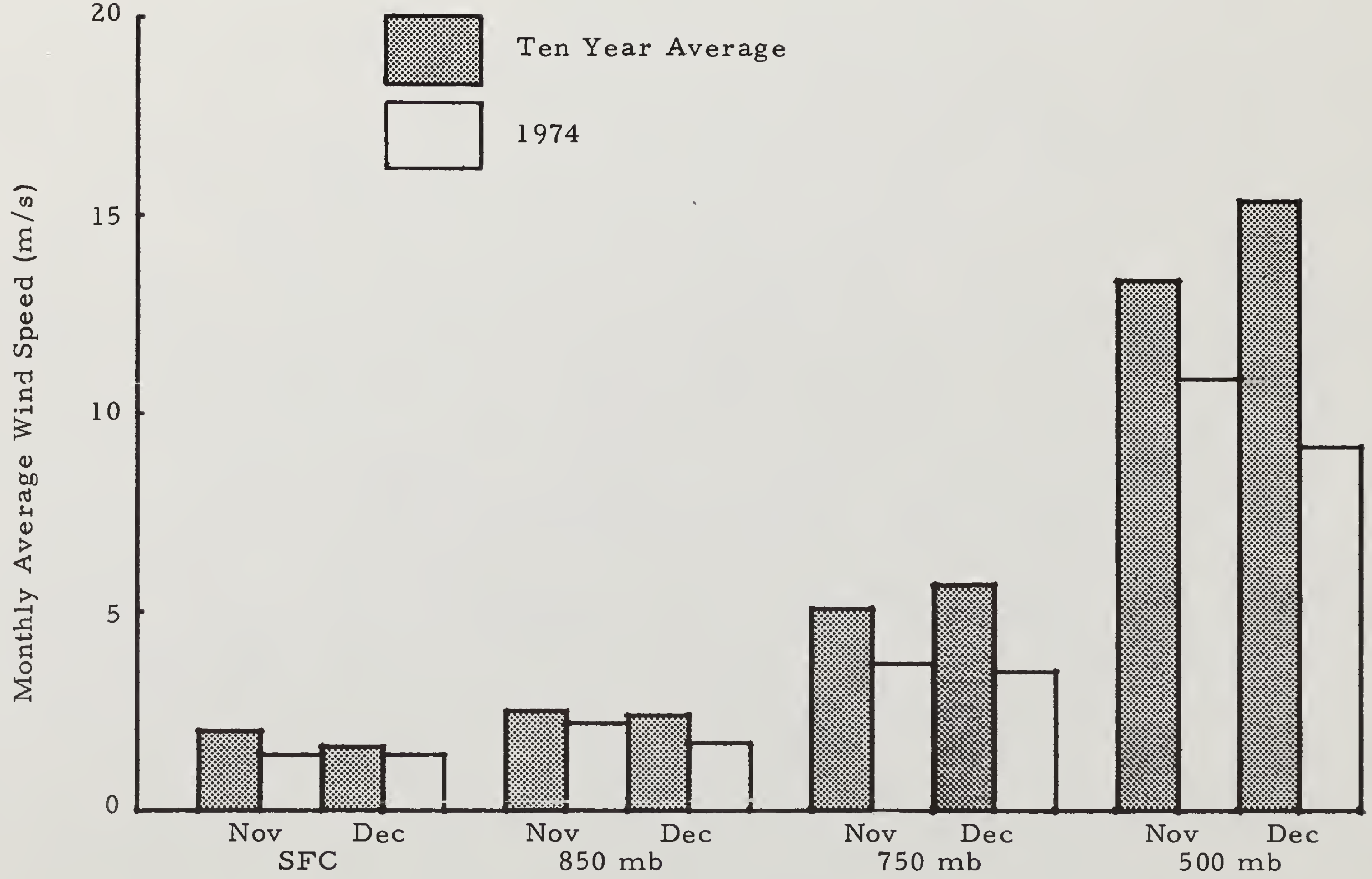


FIGURE III-8. Normality of 12Z Grand Junction rawinsonde wind speed observations for November and December 1974.

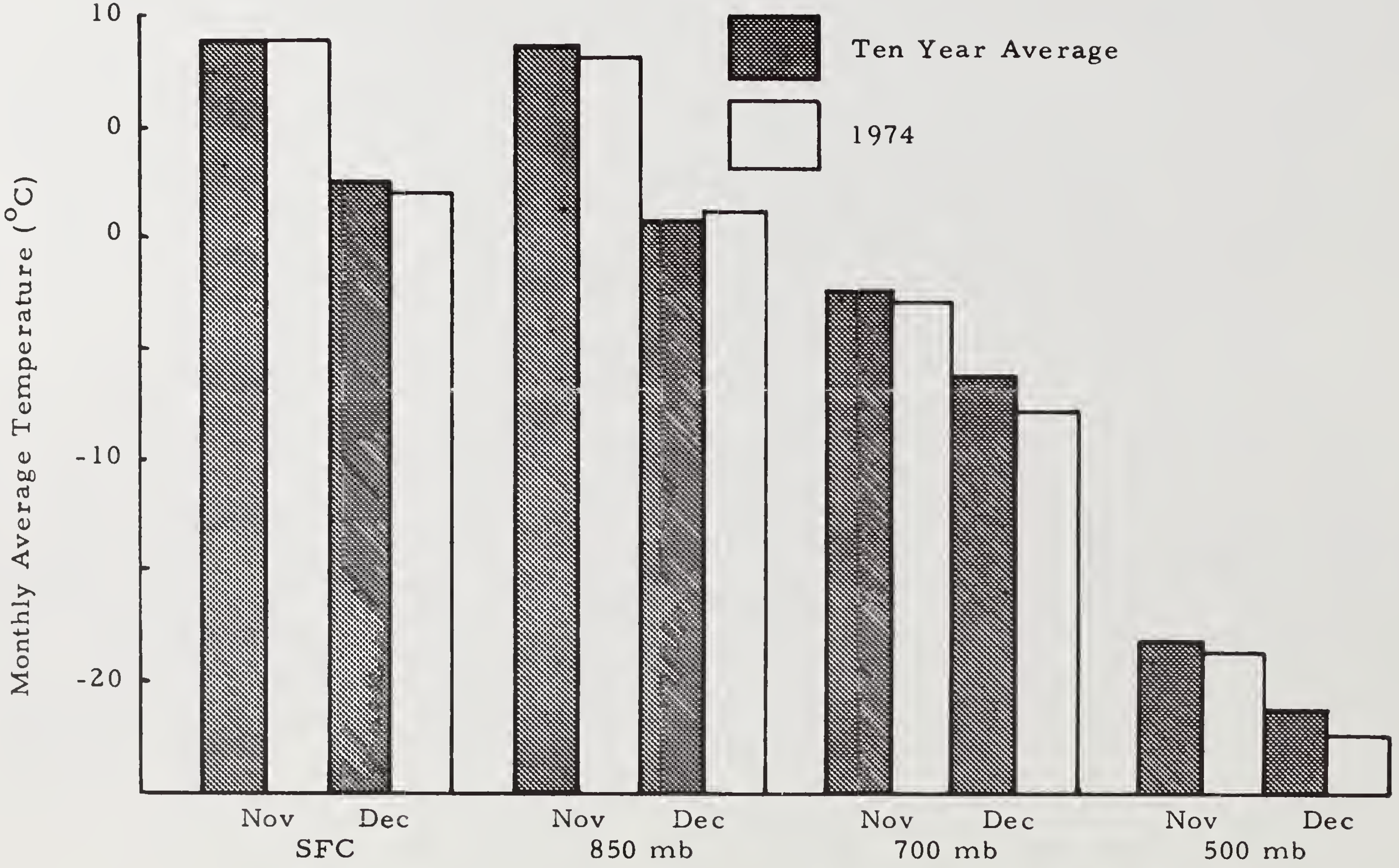


FIGURE III-9. Normality of 00Z Grand Junction rawinsonde temperature observations for November and December 1974.

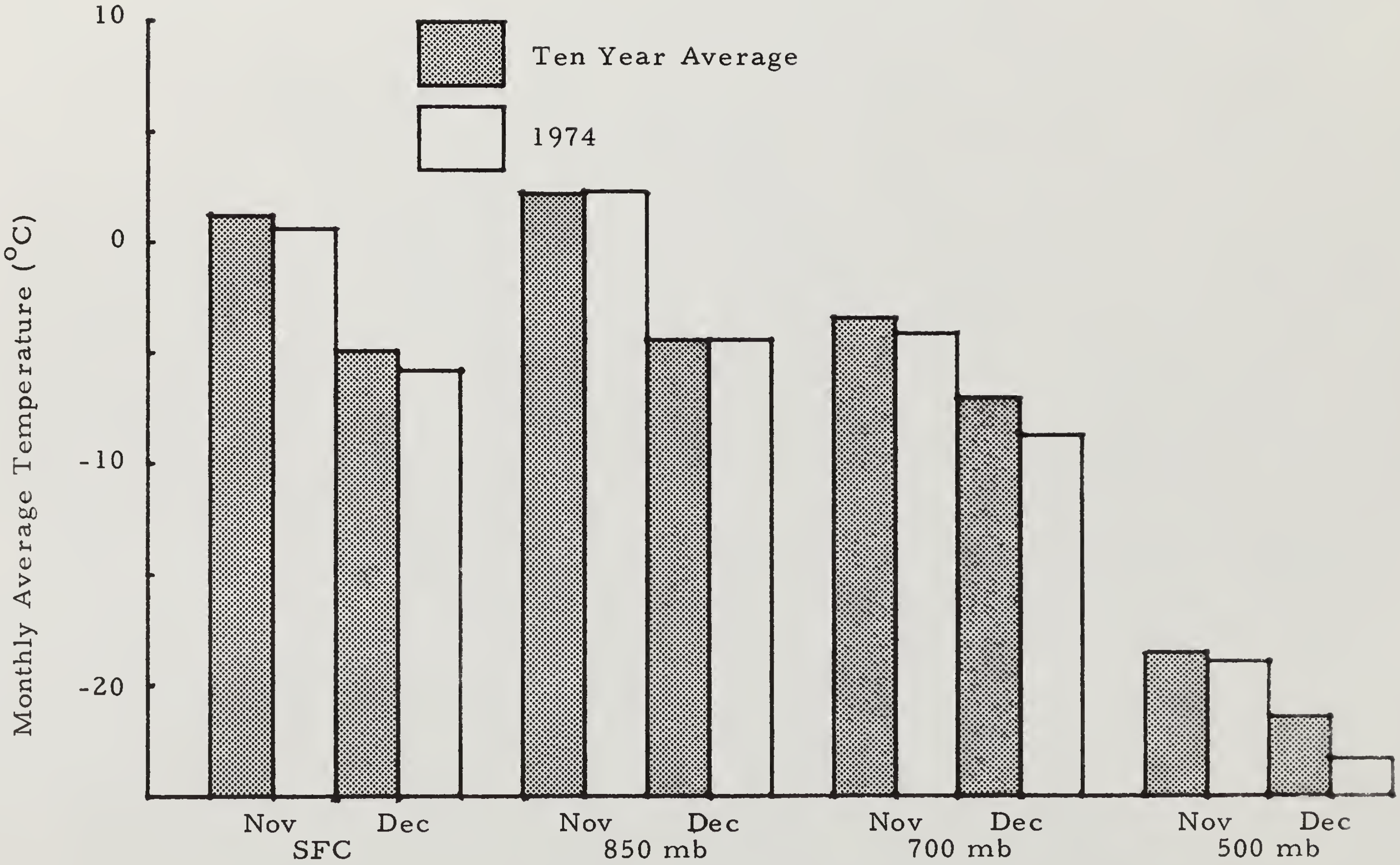


FIGURE III-10. Normality of 12Z Grand Junction rawinsonde temperature observations for November and December 1974.

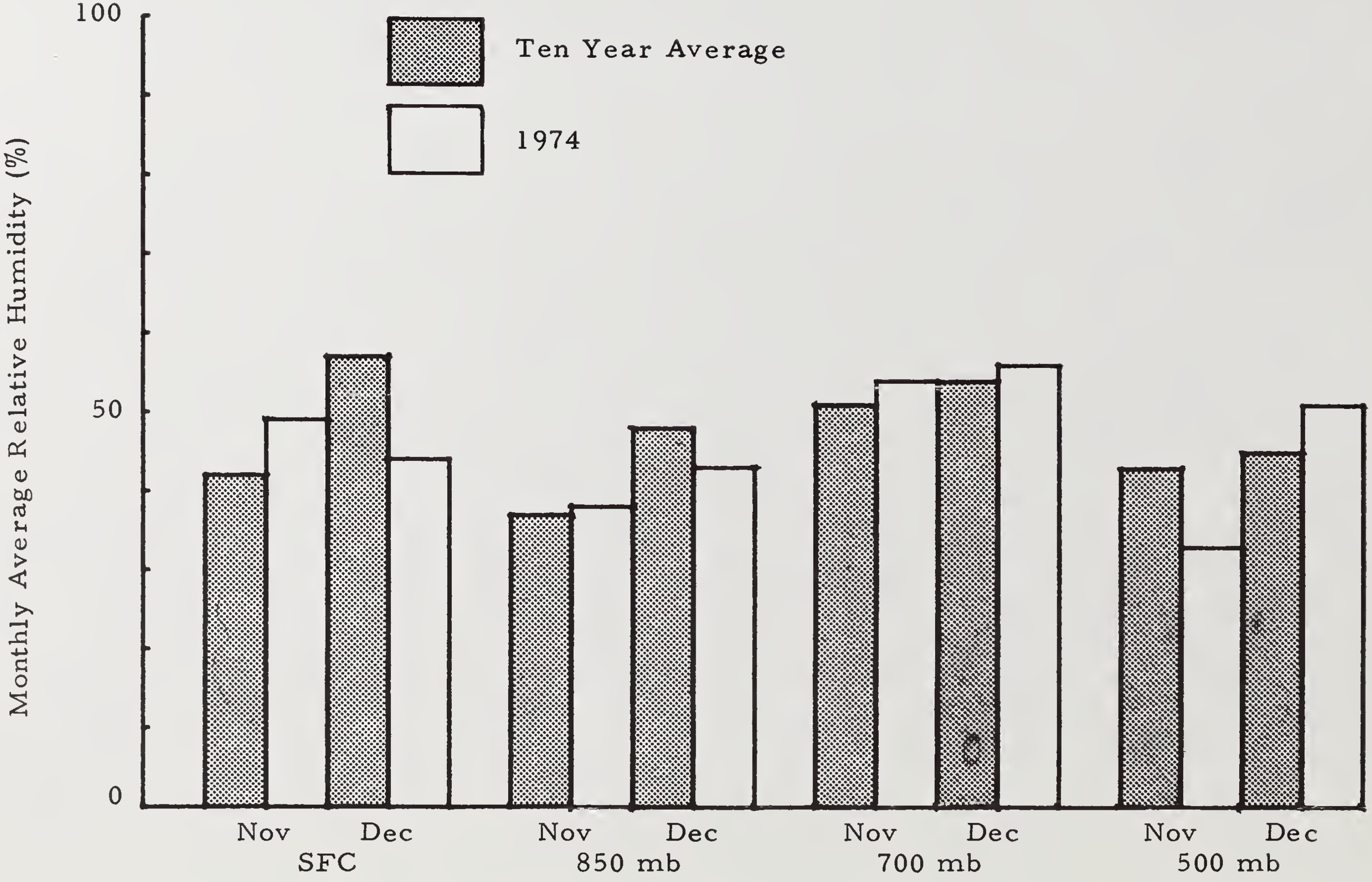


FIGURE III-11. Normality of 00Z Grand Junction rawinsonde humidity observations for November and December 1974.

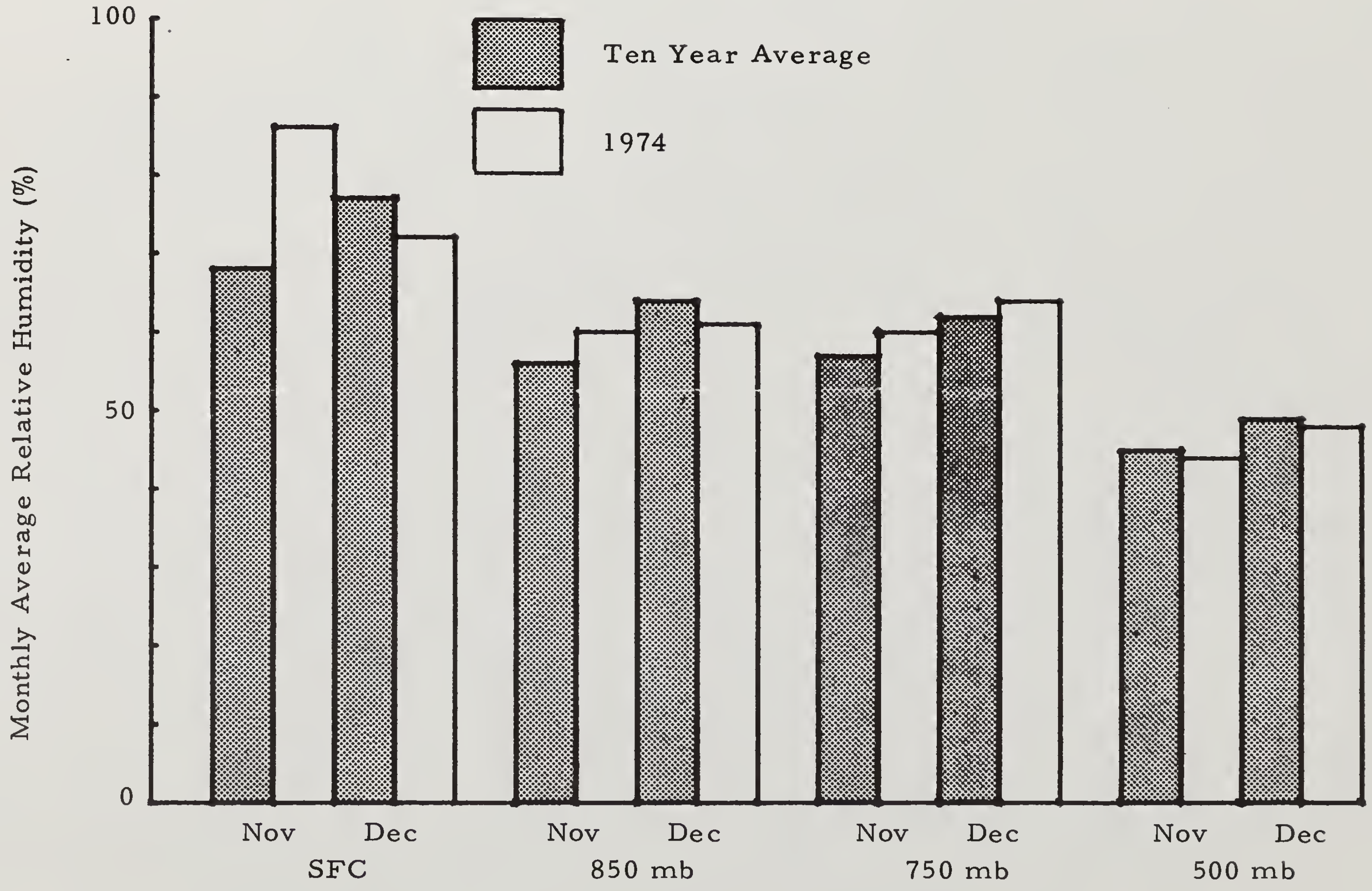


FIGURE III-12. Normality of 12Z Grand Junction rawinsonde humidity observations for November and December 1974.

the surface meteorological conditions in November and December at Grand Junction can be considered normal, and by inference the conditions on the tracts should have been relatively representative of their averages for those months.

d. Turbulence

The basic Gaussian plume diffusion equation for calculating surface concentrations directly downwind of a stack with an effective stack height H is

$$\frac{\chi}{Q} = \frac{1}{\pi\, \sigma_y \sigma_z U} \exp\left[-\frac{1}{2}\left(\frac{H}{\sigma_z}\right)^2\right]$$

where χ is the surface concentration, Q is the source emission rate, σ_y, σ_z are horizontal and vertical dispersion coefficients, respectively, and U is the mean wind speed.

For a source located at the surface (H = 0), this equation can be expressed as

$$\frac{\chi}{Q} = \frac{1}{1.38\, L \sqrt{\sigma_v \sigma_w}\, X}$$

where L is the turbulent length scale and X is the distance downwind from the source; thus, at any given location $X/Q \propto (\sigma_v \sigma_w)^{-1/2}$ and the product $(\sigma_v \sigma_w)^{1/2}$ is an index of diffusion capability, with greater diffusion and lower concentrations expected if $(\sigma_v \sigma_w)^{1/2}$ is large.

Low level turbulence on the tracts is measured in terms of the root-mean-square variation in wind direction (denoted by σ_θ) and in vertical wind speed (σ_w). The lateral diffusion speed σ_v can be computed from $\sigma_v = U \sin \sigma_\theta$.

In April, the average $(\sigma_v \sigma_w)^{1/2}$ values at 30 m at A2 at 0500 and 1400 MST were 0.25 and 0.93 m/s, respectively. Corresponding values at Station A-6 were 0.55 and 1.09. This implies that in the afternoon pollutant concentrations due to a given low-level source are expected to be two to three times lower than in the morning. Furthermore, while there is not much difference in the atmospheric diffusive capability at Stations A-2 and A-6 in the afternoon, the expected concentration from a given surface source strength in the vicinity of Station A-6 is half that at Station A-2 in the morning, reflecting the more sheltered location of Station A-2 in Southam Canyon versus the relatively open location of Station A-6.

2. AIR QUALITY

a. Gaseous Pollutants

Sulfur dioxide and H_2S are monitored at eight sites on the tracts. In addition, CO, HC, NO_2, and O_3 are monitored at three of the eight sites. There are no state air quality standards for gaseous pollutants, but federal standards exist for all components except H_2S. Table III-2 presents federal air quality standards for the various gaseous pollutants monitored on the tracts.

Air quality was very good in the last quarter, continuing the pattern of the preceding two quarters. Federal standards were

TABLE III-2. Federal Air Quality Standards for gaseous pollutants.

Pollutant	Averaging Time	Primary Standards	Secondary Standards
Photochemical Oxidants	1 hour	160 $\mu g/m^3$ (0.08 ppm)	same as primary
Carbon Monoxide	8 hours	10 mg/m^3 (9 ppm)	same as primary
	1 hour	40 mg/m^3 (35 ppm)	same as primary
Sulfur Dioxide	Annual Average	80 $\mu g/m^3$ (0.03 ppm)	-
	24 hour	365 $\mu g/m^3$ (0.14 ppm)	-
	3 hour	-	1300 $\mu g/m^3$ (0.5 ppm)
Nitrogen Dioxide	Annual Average	100 $\mu g/m^3$ (0.05 ppm)	same as primary
Hydrocarbons (corrected for methane)	3 hour (6-9 a.m.)	160 $\mu g/m^3$ (0.24 ppm)	same as primary

not exceeded for any of the gaseous pollutants except for ozone (O_3) and reactive hydrocarbons (RHC), both of which have also exceeded standards in previous quarters.

The average RHC value at Station A-2 was 12 μg/m^3 (0.02 ppm) during the last quarter and federal standards were exceeded once during the period. At Station A-6 the average RHC value in March was 45 μg/m^3 (0.07 ppm) and in April was 452 μg/m^3 (0.69 ppm). Federal standards were exceeded 22 times. The high RHC values at Station A-6 for April have not yet been explained.

To provide a perspective for evaluation of these numbers, the federal standard for RHC of 160 μg/m^3 (0.24 ppm) for the 3-hour period from 1800 to 2100 was established to reduce the formation of photochemical pollutants (for which separate standards exist also) and not as a health standard per se. Effects on human health from hydrocarbon concentrations are not known for levels below 16,000 μg/m^3 (25 ppm), which is approximately 25 to 50 times the higher values noted on the tracts. Levels exceeding the RHC standard in unpopulated areas such as the lease tracts are frequently observed throughout the United States, so the levels on the tract are not unusual.

For ozone, the peak hour and average values and the number of periods exceeding the federal standards in each month at each site are tabulated in Table III-3. The highest hourly average recorded between January and April was 198 μg/m^3 (0.10 ppm), about 20 percent above the standard. The average value on the tracts during this period was about 95 μg/m^3 (0.05 ppm), which is well below the

TABLE III-3. The peak and average values of ozone and the number of times Federal Standards were exceeded in January-April at sites A2, A3, and A6.

Site	Month	Peak Hour Value	Average Value	Number of Violations of Standards
A2	JAN	190	70	4
	APR	169	127	24
A3	JAN	190	110	41
	FEB	160	90	0
	MAR	143	90	0
	APR	147	101	0
A6	FEB	190	90	14
	MAR	145	80	0
	APR	198	180	38

standard, but at the upper end of the typical global background value range of 40-100 $\mu g/m^3$. A plot of diurnal variations in ozone concentrations at Station A-2 is presented in Figure III-13. The average value was about 50 $\mu g/m^3$ (0.03 ppm) higher in April than in January. The diurnal peak appeared between 1500-1600 MST in January and between 1100-1700 MST in April. The lateness of the peaks during the day suggests atmospheric transport of ozone from other anthropogenic or natural sources rather than ozone by photochemistry from local sources. Such transport in rural areas has been observed frequently and is the subject of a recently awarded EPA research contract.

Table III-4 presents the highest and the average values for other gaseous pollutants at Stations A-2 through A-8. (The only gaseous pollutant monitoring instrument at Station A-1, a gas chromatograph for SO_2 and H_2S, was inoperative for much of the last quarter, and data collected at this site were too incomplete for valid statistical analysis.) Very little diurnal variation was observed for any of these pollutants. Furthermore, the measured values were very low, frequently near the detection threshold of the instruments, and all well below any applicable standards. Throughout this study, Station A-7 has shown consistently higher H_2S values than have the other stations, possibly because of its proximity to mining and refuse disposal areas near Bonanza. Other H_2S and SO_2 variations are simply due to variability in instrument responses near their detection thresholds.

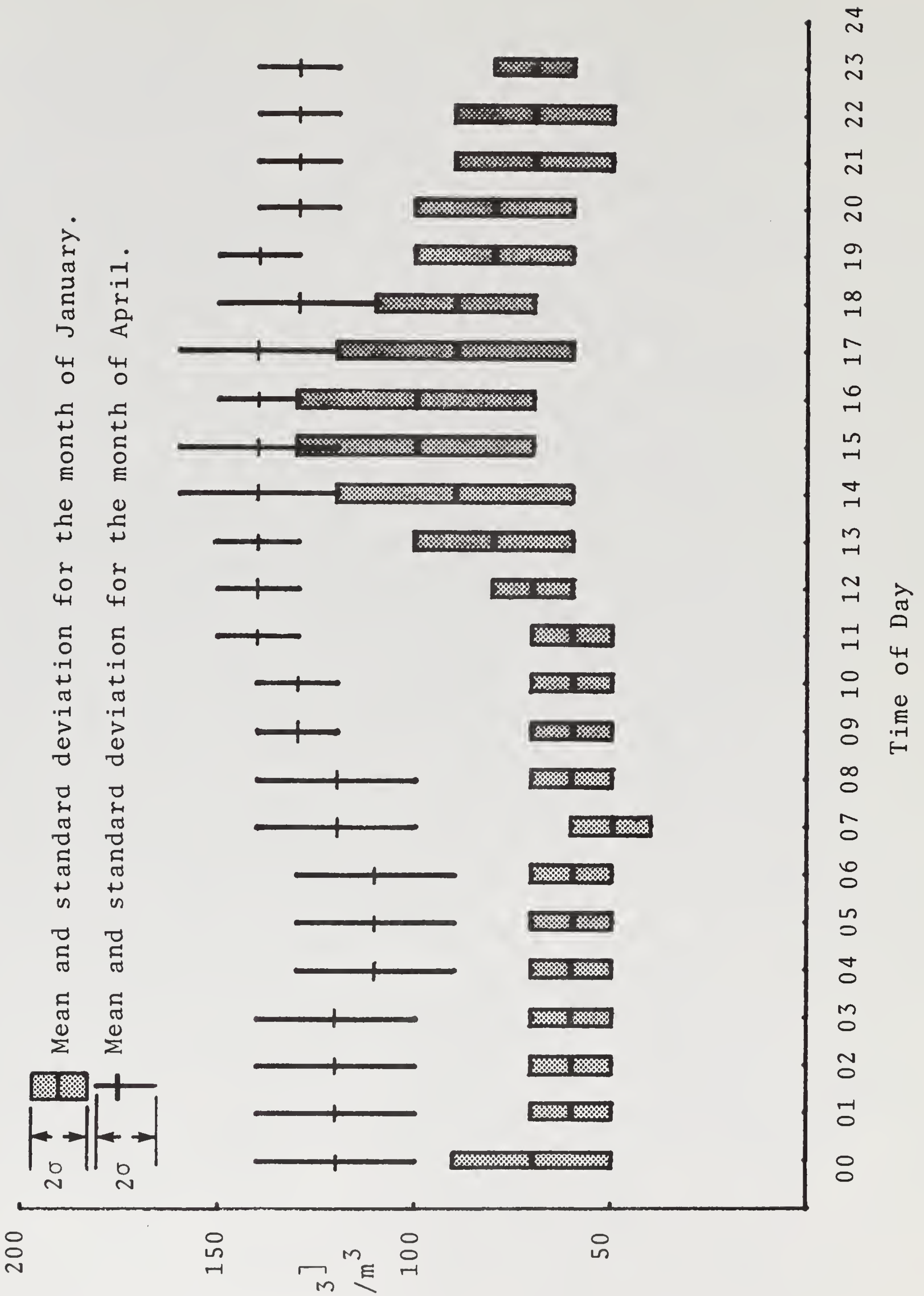


FIGURE III-13. Diurnal variations in ozone concentrations at A2 in January and April.

TABLE III-4. The highest and average values of SO_2, H_2S, CO, and NO_2 measured at sites A2-A8 during the spring quarter.

Pollutant	Site	Highest Value	Average Value
SO_2 ($\mu g/m^3$)	A2	3	0
	A3	16	6
	A4	5	0
	A5	20	3
	A6	9	1
	A7	29	13
	A8	10	2
H_2S ($\mu g/m^3$)	A2	10	1
	A3	17	7
	A4	0	0
	A5	7	1
	A6	32	15
	A7	60	43
	A8	10	2
CO (mg/m^3)	A2	2	0
	A6	1	0
NO_2 ($\mu g/m^3$)	A2	133	27
	A3	32	13
	A6	0	0

Note: Nominal detection limit for instrumentation on the tract is:

SO_2 - 13 $\mu g/m^3$ (.005 ppm)
H_2S - 7 $\mu g/m^3$ (.005 ppm)
CO - 0.1 mg/m^3 (0.1 ppm)
NO_2 - 10 $\mu g/m^3$ (0.005 ppm)

As a comparison of the air quality on the tracts between the last two quarters, relative frequency distributions of pollutant concentrations of SO_2 and H_2S observed in January and April at Station A-6 and relative frequency distribution of concentrations of CO, NO_2, and O_3 at Station A-2 are given in Table III-5. Since station-to-station variability has been shown to be small between Stations A-2 and A-6, either of these sites could have been selected for this table. The sites selected for each pollutant was thus chosen on the basis of maximum reliability of instrumentation during these two comparison months.

With the exception of O_3 and NO_2, essentially all of the measured data lies in the first (lowest) interval of the distribution at a level typically 10 percent of the Federal Ambient Air Quality Standard. The ozone distribution has changed considerably from winter to spring, with an increased frequency of near-standard values in April. The NO_2 distribution change between January and April may have been artificially caused by the propane generators. Although obviously contaminated readings such as those caused by a puff of exhaust gas reaching the sample inlet have been deleted, any low level, area-wide contamination impact of generator exhaust cannot be determined. The generally higher winds in April could have lessened this impact. Since the Station A-2 generator was turned off at the end of April, study of NO_2 distribution changes in the autumn of 1975 as the windiness decreases will show whether this was indeed the case. Nevertheless, with or without generator exhaust impact, the values are all very low and in the normal background range.

TABLE III-5. Relative frequency distribution (%) of concentrations of CO, NO_2, and O_3 at A2, and SO_2 and H_2S at A6 in January and April. Values above the double line exceed a short-term Federal Ambient Air Quality Standard.

CO (mg/m^3) SITE: A2

Conc. Month	0-1.9	2.0-3.9	4.0-5.9	6.0-100	> 10
JAN	> 99	< 1	0	0	0
APR	> 99	< 1	0	0	0

O_3 ($\mu g/m^3$) SITE: A2

Conc. Month	0-59	60-99	100-129	130-160	161-200
JAN	23	67	7	2	1
APR	0	5	30	60	5

NO_2 ($\mu g/m^3$) SITE: A2

Conc. Month	0-24	25-49	50-74	75-100	> 100
JAN	64	25	11	< 1	0
APR	98	2	< 1	0	0

H_2S ($\mu g/m^3$) SITE: A6

Conc. Month	0-12	13-22	23-32	33-42	> 42
JAN	> 99	< 1	0	0	0
APR	1	89	10	0	0

SO_2 ($\mu g/m^3$) SITE: A6

Conc. Month	0-15	16-30	31-100	100-365	> 365
JAN	100	0	00	0	0
APR	100	0	0	0	0

b. Particulates

Particulate concentrations on the tracts are monitored by high volume samplers for 24 hours every six days simultaneously at all eight air monitoring sites. Table III-6 presents the geometric mean, standard geometric deviation, and maximum and minimum particulate concentrations in μg/m^3 at all sites in the winter and spring quarters.

Because particulate concentrations have been lognormally distributed in general, the geometric mean corresponds to the maximum concentration expected at a 50 percent frequency. The average geometric mean on the tracts for all stations was about 9 μg/m^3 in the first quarter and about 15 μg/m^3 in the second quarter. Particulate concentrations were very low before April 6 because of snow cover on the ground surface which suppressed the introduction of dust and fine soil particles into the atmosphere by wind and vehicular activities. The highest particulate concentrations so far observed throughout the tracts occurred on April 6 when all sites recorded higher than 25 μg/m^3. The highest single reading recorded to date was 52 μg/m^3 at Station A-6 on April 24, followed by a reading of 49.9 μg/m^3 at Station A-3 on April 6. Stations A-5 and A-6 consistently registered higher values than did the other stations, possibly because of the vehicular activity along Utah Highway 45, which passes near both.

None of the recorded values violated federal or state standards, seen in Table III-7. The most stringent standard is the National Secondary Standard, which sets the upper limit at 150 μg/m^3

TABLE III-6. The geometric mean, standard geometric deviation, maximum and minimum of particulate concentrations ($\mu g/m^3$) at sites 1-8 in the winter (W) and spring (S) quarters. (Sampler malfunctions at A6 in the winter quarter reduced the number of available data points to too small a number for meaningful statistical analysis.)

	Geom. Mean		Std. Geom.Dev.		Max		Min	
Site	W Qtr	S Qtr	W Qtr	S Qtr	W Qtr	S Qtr	W Qtr	S Qtr
1	9.11	11.5	1.34	1.70	14.5	29.1	4.0	4.6
2	8.12	11.1	1.46	1.93	15.8	41.7	3.3	3.9
3	9.41	12.1	1.31	2.08	15.6	49.9	6.5	4.3
4	7.76	14.0	1.51	1.84	15.9	44.5	4.6	6.0
5	11.45	21.0	1.38	1.69	19.8	49.5	5.3	8.7
6	-	17.2	-	1.94	-	52.0	-	6.9
7	8.19	10.5	1.34	2.05	13.8	46.7	5.9	2.6
8	7.15	21.8	1.44	1.78	12.4	48.4	5.3	8.0

TABLE III-7. Ambient air quality standards for particulate matter ($\mu g/m^3$).

Pollutant	Averaging Time	Utah Standards	National Standard	
			Primary	Secondary
Suspended Particulate Matter	Annual Geometric Mean	90	75	60
	24 hour	200	260	150

averaged over 24 hours; this is not to be exceeded more than once a year. The highest recorded particulate concentration on the tracts (52 $\mu g/m^3$) is well below this level and is even below the national annual geometric mean standard.

c. Trace Metals

Samples are collected at Station A-2 by a multistage Lundgren impactor and analyzed for elements by ion-excited X-ray emission techniques. Sensitivities of analysis vary from 1 ng/m^3 (10^{-9} $gram/m^3$) to, in some unfavorable cases, a few hundred ng/m^3. Absolute analytical accuracy is nominally ±10 percent although this varies depending on the particular element being studied. The sensitivity of the method can be improved by loading more samples on each filter (hereafter referred to as heavy loadings) and by a longer analysis time. The combination of these two techniques can lead to a 30-fold increase in sensitivity. Light elements (H to F) can also be detected by the high sensitivity technique, with detection limits for Li, Be, B, N and F at 0.1 $\mu g/m^3$; for C and O at 5 $\mu g/m^3$; and for H at 1 $\mu g/m^3$.

Single-day samples were collected from January 29 to February 11, and heavy loadings were collected from February 17 to March 8, April 4 to 19, and May 1 to 13. All single-day samples were analyzed by normal 5-microcoulomb (mc) runs. The first set of heavy loading samples was analyzed at 5 and also at 50 microcoulombs. Based on the results of these early runs, the rest of the heavy loading samples were analyzed at 50 microcoulombs. Results of the analysis of samples collected on May 1-13 are not yet available.

Results of the 5μC and 50μC runs for samples collected from February 17 to March 8 indicate that concentrations of elements reported by the 5μC run agree reasonable well with concentrations of corresponding elements reported by the 50μC run. In addition, more elements are being detected with the higher sensitivity analysis (50μC).

Table III-8 shows the elements in three size ranges detected during the sampling periods. The air quality with respect to trace metals was exceptionally good: most of the elements were detected at concentrations less than or around 10 ng/m^3. The concentration of each element was mainly in the smaller size fractions before April.

Elements that existed in larger quantities were Si, S, K, Ca, and Fe. Elements usually strongly correlated with soil include Al, Si, K, Ca, Ti, Mn, and Fe. The April value for Si being more than double the March value and the increasing dominance of larger particle sizes in April indicate a natural, soil-derived aerosol that will sharply increase with warm, dry weather.

Typical anthropogenic aerosols such as S, Cu, Zn, and the automotive-derived aerosols of Br and Pb were very low, only a small percentage of existing urban values. For comparison, the average concentration of S, Cu, Zn, Br, and Pb in Sacramento, California, between January 1 and March 31, 1974, were 651, 15, 80, 255, and 820 ng/m^3, respectively. On the tracts, concentrations of these anthropogenic aerosols were lower in April than in previous months, reflecting a drop in project activities (drilling, etc.) as well as increased ventilation in spring.

TABLE III-8. Trace elements detected at site A2 using ion-excited X-ray emissions technique. Any elements not shown have not been detected.

Sampling Record	Sensitivity of Analysis	Size (μm) Range	Li	Be	Na	Mg	Al	Si	S	Cl	K	Ca	Ti	V	Cr	Mn	Fe	Ni	Cu	Zn	As	Se	Br	Rb	Sr	Zr	Ba	Pt	Au	Hg	Pb
1/29-2/11	5 μC	3.6-20.0	-	-	B	B	★	C	A	B	B	B	A	A	A	A	B	A	A	A	-	-	★	-	-	-	B	-	-	-	A
		.65-3.6	-	-	B	A	A	D	C	★	A	B	A	A	A	A	B	A	A	A	-	-	★	-	-	-	A	A	-	-	B
		.10-.65	-	-	C	B	B	D	D	C	C	B	★	B	B	B	B	A	B	B	C	-	B	-	-	-	B	B	B	-	D
2/17-3/8	50 μC	3.6-20.0	-	-	A	-	A	B	B	★	A	A	A	★	-	A	B	★	A	A	★	-	A	-	A	-	★	A	★	-	A
		.65-3.6	A	★	A	-	A	B	B	★	A	A	A	★	-	A	B	-	A	A	-	★	★	-	★	★	★	★	★	★	A
		.10-.65	-	-	B	-	B	C	C	★	B	B	★	★	-	A	B	★	A	A	-	★	A	★	-	-	★	★	★	★	B
4/4-4/19	50 μC	3.6-20.0	-	-	A	A	B	D	A	A	B	B	B	A	-	A	B	-	A	A	-	-	★	-	-	-	★	-	-	-	A
		.65-3.6	-	-	A	A	B	D	C	★	B	B	A	★	-	A	B	-	A	A	-	-	★	-	-	A	★	-	-	-	A
		.10-.65	-	-	A	-	A	C	C	★	A	B	A	A	-	★	B	-	★	A	-	-	A	-	-	-	★	-	-	-	A

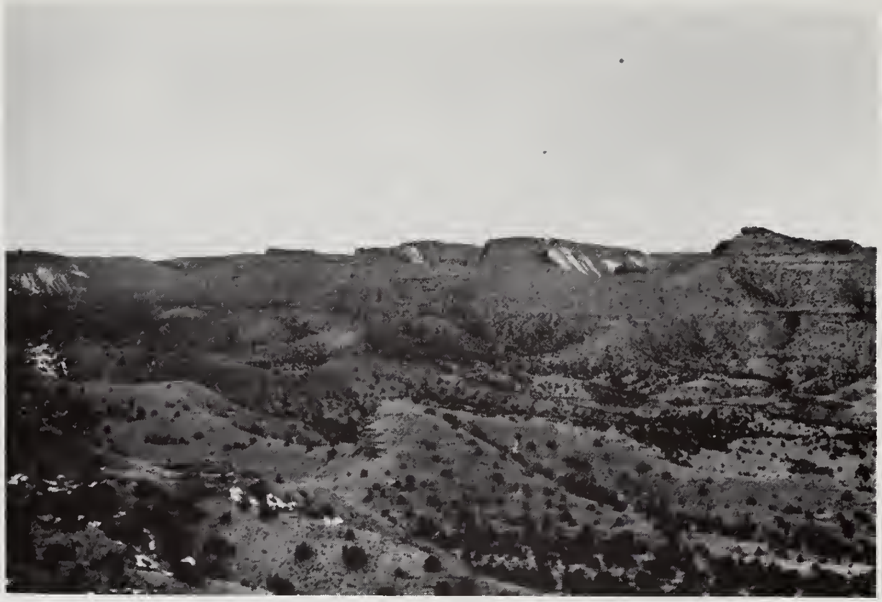
-	Element not found
★	Conc. < detection limit
A	10 ng/m^3 > conc. > 0 ng/m^3
B	50 ng/m^3 > conc. > 10 ng/m^3
C	100 ng/m^3 > conc. > 50 ng/m^3
D	500 ng/m^3 > conc. > 100 ng/m^3

Many elements seen in February and March were absent in April. These elements included Pt, Au, Hg, As, Se, Sr, and Cr. This might be due to transport from some anthropogenic source. As a side note, the detection of Pt was very significant because it was the first time this element was ever detected by this technique. Normally, other elements in the atmosphere obscure the Pt spectrum. Relatively large amounts of lead in the size range of 0.1-0.65u were detected January 29 (470 ng/m^3) and February 3 (631 ng/m^3). This is probably caused by vehicular activities and drilling associated with the geologic exploration program, at its peak at that time.

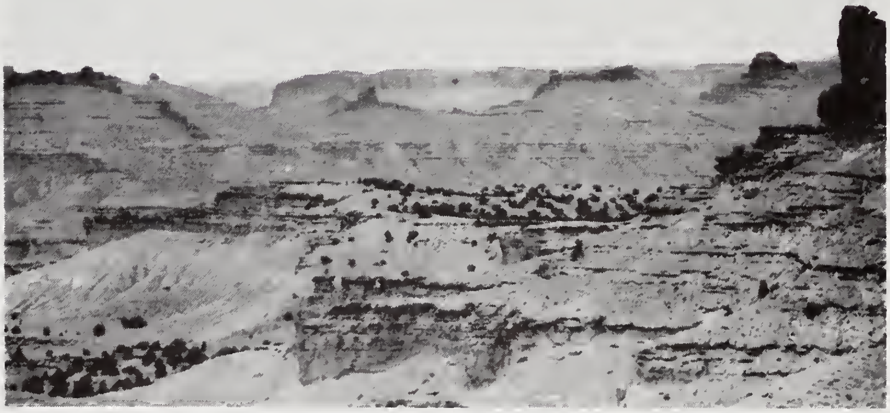
d. Visibility

The clarity of the atmosphere on the tracts is monitored by three methods: (1) continuous recording of light scattering coefficient with an integrating nephelometer at Station A-2; (2) photographic recording of visibility on color and monochromatic film from an observation point above Station A-9; and (3) visual observations at the same time as the photographic records are made.

Photography is performed for one day at intervals of 30 days, with pictures taken at 0800, 1200, and 1600 MST (with extra sequences inserted occasionally). Figure III-14 displays the photographic panorama observed from the visibility photo site on a typical day. Photographs are taken every 45° from west to southeast. The 90° segment, including the southern and southwestern directions, is blocked by nearby high terrain. The direction due north of the cameras is also blocked by terrain, but this direction is

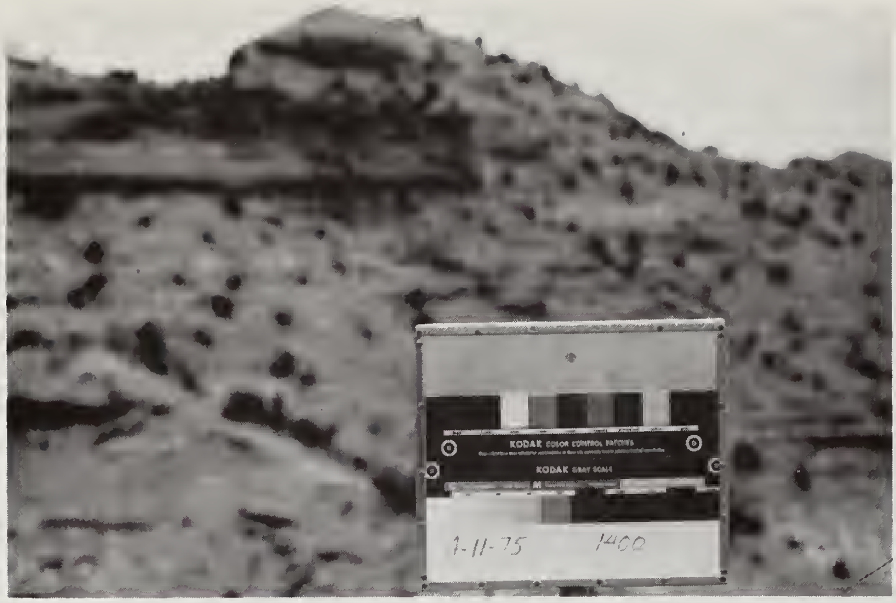


a. West

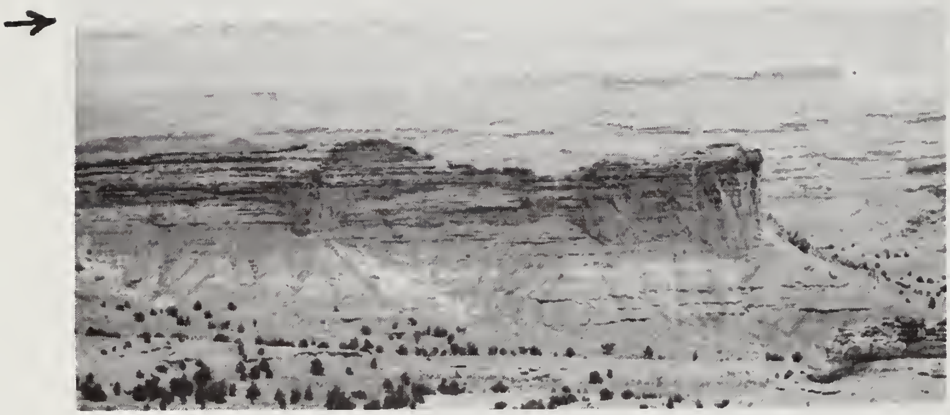


b. Northwest

FIGURE III-14. Photographic visibility record for 1400 on 11 April 1975. The weather on this day was overcast and clouds obscured very remote terrain. The photographs are spaced at 45° intervals around the horizon, and the field of view of each is about 35°.

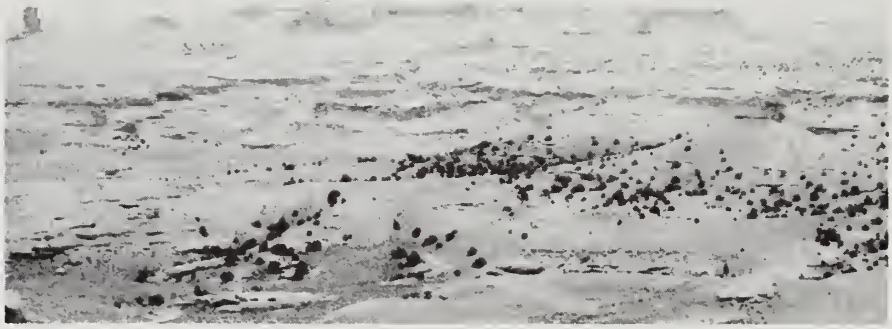


c. North. Identification sign and control charts. Camera is focused on sign, so terrain is out of focus.

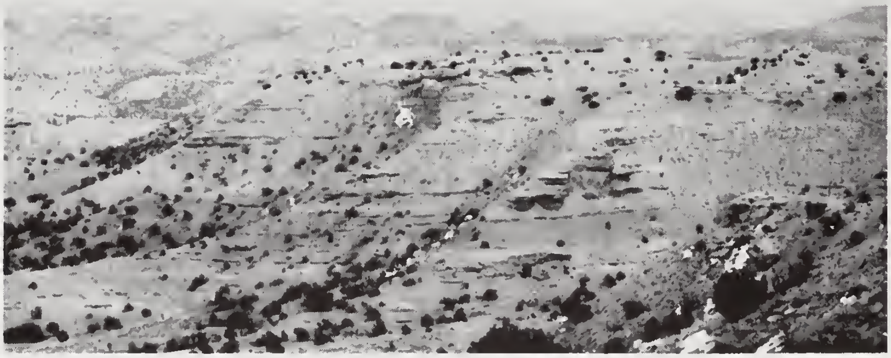


d. Northeast.

FIGURE III-14, continued. Note hazy appearance of distant Blue Mountain (indicated by arrow), some 60 km to the northeast, because of moisture in the air.



e. East.



f. Southeast.

FIGURE III-14, continued. Clouds obscure portions of the Rabbit Hills (20 km to the east); the Cathedral Bluffs (50 km to the east) are not visible.

used for photographing an identification sign which also contains standard resolution, color, and gray scales (the resolution chart is missing on the photo in Figure III-14). These standard charts are used as controls for printing the photographs which serve as the permanent visibility record.

The integrating nephelometer gave an average scattering coefficient of $0.06 \times 10^{-3} m^{-1}$ during this quarter, which corresponds to a local visual range (assuming a 2 percent contrast threshold for the eye) of 79 km (49 miles). The highest scattering (lowest visual range) recorded was $b_s = 0.10 \times 10^{-3} m^{-1}$, which corresponds to 47 km (29 miles); the most clear hour showed $b_s = 0.05 \times 10^{-3} m^{-1}$ (visual range 94 km or 58 miles). These values are somewhat higher in scattering and lower in visibility than those of the winter quarter. In particular, no data were seen this quarter showing air clarity comparable to that of particle-free air, in contrast to the values of the winter quarter. All observed values have corresponded to extremely clear air quality.

A diurnal variation in scattering coefficient was observed. The night and early morning hours showed about 15 percent more scattering (lower visibility) than did the afternoon and evening hours. This diurnal effect shows that fine-scale particulates (of natural or anthropogenic origin, e.g., from generators and 24-hour a day well drilling) collect near the ground during the stable, calm night hours and are mixed into the atmosphere during the better ventilated hours, and that increased human activity and winds on the tract during the day do not stir up enough dust to counteract this stability. Obviously, the summer trends should be quite different.

During the hour when the photographs in Figure III-14 were taken, the scattering coefficient was $0.06 \times 10^{-3} m^{-1}$ and the local visual range was 79 km (49 miles). As the photos show, this visual range could not be observed in some sectors because clouds remote from the tracts obscured terrain at such distances. The view to the northeast does show Blue Mountain at 60 km, in good agreement with the nephelometer value; no more remote landmarks exist in that direction to validate the 79 km nephelometer figure, however.

3. RADIATION

Continuous monitoring of ambient radiation throughout the tracts by a pressurized ion chamber and by a portable ionization chamber survey meter and a NaI crystal scintillation counter all show that radiation throughout the study area is in the normal ambient range. The pressurized ionization chamber set up at each site in turn for six consecutive days shows exposure rates varying from 8 to 18 uR/hr* averaged over the six-day period, with single hour averages ranging from 6 to 20 uR/hr. Localized sources in the vicinity of the monitoring sites have indicated values up to about 50 uR/hr and 26 urad/hr, still well within the background range. No significant seasonal variability in radiation levels has yet been observed.

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*Recent convention requires that exposure rates be given in terms of rad/hr rather than R/hr. Since the conversion from one to the other is a function of the energy spectrum of the radiation, such conversion requires detailed knowledge of the calibration and design of the measurement instrument. This is currently being explored; in the interim, data is given in the units for which the instrument was calibrated (uR/hr for the pressurized ion chamber and the NaI crystal ratemeter, and urad/hr for the portable multiplying ion chamber). To first order, 1 rad ≃ 1 R (Roentgen).

Particulate matter collected on the high-volume sampler filters at Stations A-2 and A-6 is analyzed for radiation by a gross alpha and beta measurement and a qualitative gamma radiation scan. Results of the analyses of filters for January through March 1975 were just received as this report was being prepared. Although detailed interpretation could not be done for this report, the analyses showed all radioactive isotope activities to be in the background range.

An air sample taken in Decembers 1974 showed a radon-222 activity of 0.64 pCi/l (pico-curie/liter). According to the EPA National Environmental Research Center in Las Vegas, which analyzed this sample, values below 1.0 pCi/l are considered normal background levels.

A memorandum describing the radiation measurement program was sent to various individuals in EPA, ERDA, and the State of Utah, following up a request for continuous updates of program activity by these individuals.

4. SOUND LEVELS

A sound level survey of the study area was performed April 9 through 10 using a hand-held precision sound level meter with

A-scale (human aural response) filtering and a slow response setting. This survey showed that in wind-free conditions the background sound level at various locations was 26 dB(A) (decibels), with no identifiable dominant sound source. Two sites near the White River (Stations A-1 and A-5) both indicated 30 dB(A) with no wind, with the sound of water being identified as a sound source. Increases in wind caused higher sound levels, with 60 dB(A) recorded at Station A-4 in a 5 m/s (11 mph) wind.

For reference, the threshold of hearing is taken as 0 dB(A), a quiet residential bedroom may be at 25-30 dB(A), and a quiet office at 40 dB(A). Forested or grassy regions typically show 50 dB(A) in no-wind conditions. OSHA occupational safety regulations prohibit exposure to more than 90 dB(A) for an 8-hour day. The sound environment on the tracts can be considered very quiet during the spring quarter.

At locations where generators were still running, these measurements were made sufficiently far from the site (typically 365 m) so that the generator could no longer be heard by the technician taking the measurements. The generator could still be heard slightly about 90 m away from Station A-2, and the sound level was 36 dB(A), about three times the 26 dB(A) background value.

5. A CASE STUDY OF METEOROLOGY, DIFFUSION, AND AIR QUALITY: FEBRUARY 19-21, 1975

a. Description of Experiment

Special experiments were conducted February 19 through 21 to study the diffusive characteristics of the lower atmosphere on the tracts and the variability of ozone and suspended particulates within a 40-km circle around the tracts.

During this period, detailed measurements of atmospheric stability and turbulence were made three times daily from the surface at Station A-6 up to 4,300 m (14,000 ft) MSL with a specially instrumented aircraft. Simultaneous rawinsonde launches provided independent temperature data plus humidity and wind profiles while pilot balloon launches gave finer details of wind structure aloft.

The diffusive capability of the atmosphere was observed directly by releasing colored smoke from tethered balloons at 90 m (300 ft) and observing by a probing aircraft equipped with an integrating nephelometer the subsequent motion and decay of the smoke concentration. Surface-based photography was also used. Figure III-15 shows a smoke release being probed by aircraft.

Horizontal and vertical ozone and particulate profiles also were surveyed by aircraft. Low-level profiles were measured at an altitude of 2,100 m (7,000 ft) MSL out to 40 km from Station A-6 and in the area between Vernal and the tracts; and vertical profiles were recorded at Vernal, site A-6, and at various locations 40 km from Station A-6. The purpose of these measurements was to explore possible causes for the previously observed higher-than-normal background ozone levels in the area to study the differences in ozone and particulate levels between the urbanized and undeveloped areas in the Uinta Basin. Useful measurements were made on all three days, although a low overcast on February 20 prevented aircraft operations throughout that day, and high

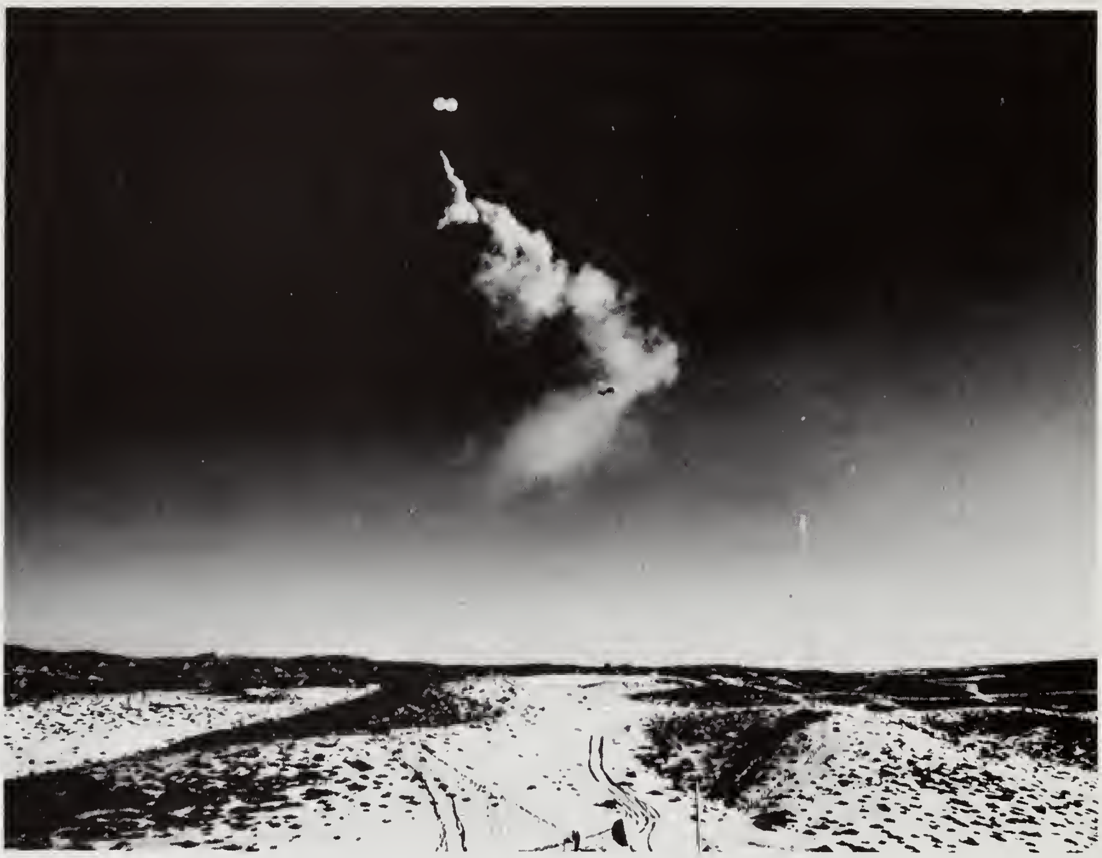


FIGURE III-15. Smoke plume emitted from smoke grenades supported 90 m above the surface by tethered balloons at site A6 during calm conditions at 0820 on the morning of 21 February. An instrumented aircraft is probing the plume at the center of the photograph. (The wide-angle lens used for this photo distorts angles, thus the normally vertical 30 m tower at A6 appears to lean to the left.)

winds in the late afternoon on February 21 precluded use of the tethered balloon smoke release system.

This experiment, performed too late during the winter quarter for inclusion in the second quarterly report, was designed as a general research experiment to provide basic data on various meteorological and air quality phenomena in the tracts area. It was not designed specifically to portray diffusion from a particular plant configuration. As such, it was performed at Station A-6 simply because of the preponderance of meteorological equipment, including the rawinsonde station. The smoke release height of 90 m was selected arbitrarily because it might represent the future release height for some pollutants and because it was sufficiently far above the surface to escape the influence of fine-scale details of surface topography and micrometeorology. Actual effective release heights of future sources on the tracts would probably range from the surface to considerably in excess of the level used here.

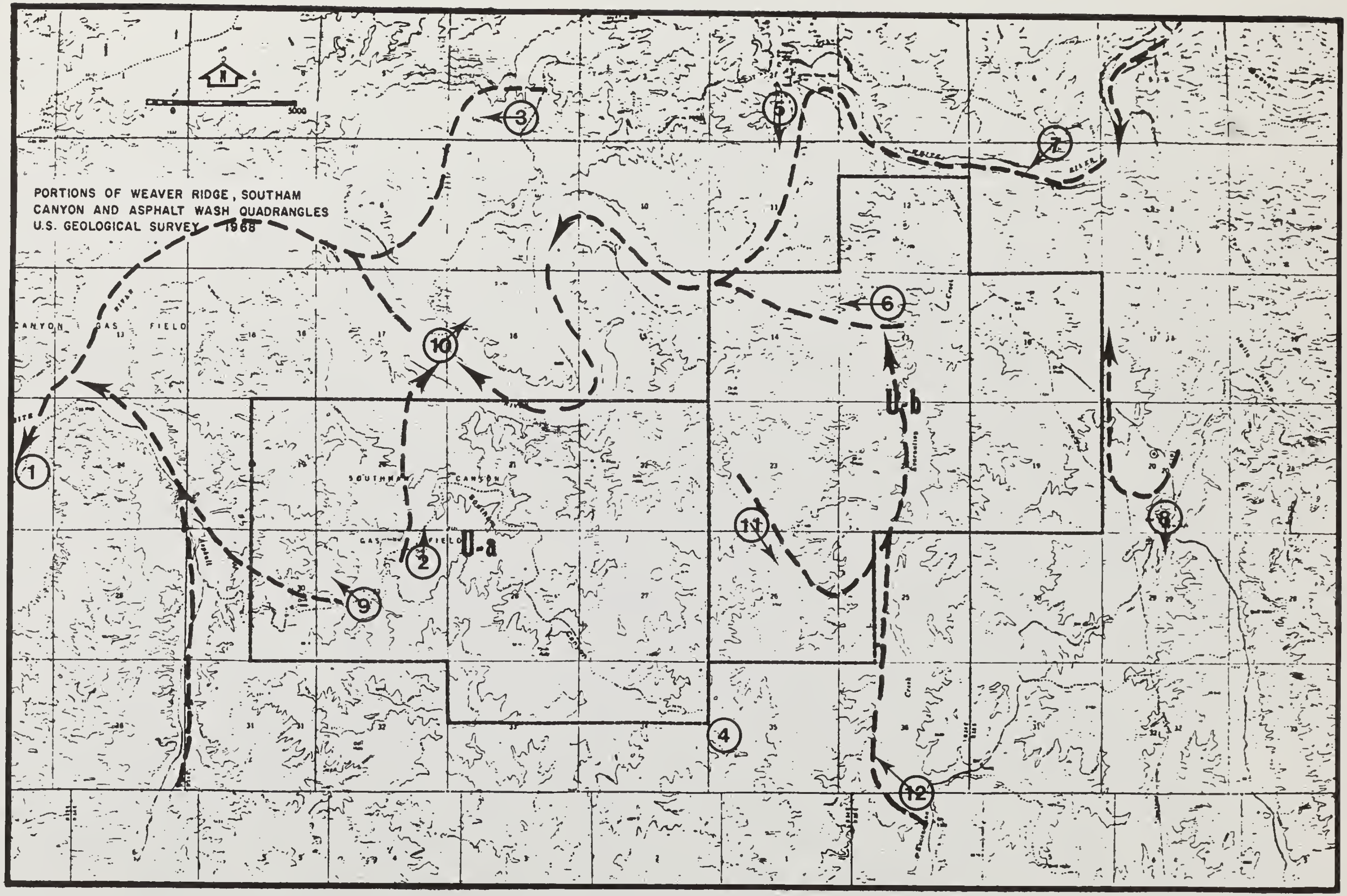
b. The Meteorological Situation

On February 19, surface barometric pressure at Station A-6 began dropping at 0900 MST and by 2300 MST it had dropped from 633 mm Hg (24.94 in) at 0900 MST to 625 mm (24.62 in). On February 20, it remained around 622 mm (24.5 in). Pressure rose again on the twenty-first from 626 mm Hg (24.66 in) at 0000 MST to 633 mm (24.94 in) at 2300 MST. The average daily pressure at Station A-6 for the month of February was about 632 mm (24.9 in) with a difference between the diurnal peak and low of about

5 mm (0.2 in), indicating that a low pressure cell moved over the tracts during the period of the experiment. This is also indicated by the snowfall and overcast skies February 20.

Plots of airflow on the nineteenth are presented in Figures III-16, III-17, and III-18. In the early morning hours, drainage flow dominated the surface flow pattern, as depicted in Figure III-16. Towards noon the winds began increasing and a transition to a westerly flow pattern began to emerge (Figure III-17). Later that afternoon, toward 1600 MST, the flow was totally from the northwest (Figure III-18). During the day, the anemometers at Stations A-2 and A-9 indicated winds from the northeast and were out of alignment with the general system. This is attributed to topographic influences and seems to reflect a localized upslope flow.

Pilot balloon (pibal) and rawinsonde soundings both showed strong upper level westerly winds on February 19. Pibal trajectories, presented in Figure III-19, show that at noon the pilot balloon traveled toward the southeast after release, turned north after about 4 minutes (at about 800 m above ground level), and headed eastward after another 2 minutes (at 1200 m AGL). In the evening the balloon took off toward the southeast, headed north about 2 minutes (400 m) later, then slowly turned toward the east. The morning launch on the nineteenth is not shown because tracking the balloon was terminated 3 minutes after launch when the balloon was lost in low clouds.


PORTIONS OF WEAVER RIDGE, SOUTHAM CANYON AND ASPHALT WASH QUADRANGLES U.S. GEOLOGICAL SURVEY 1968
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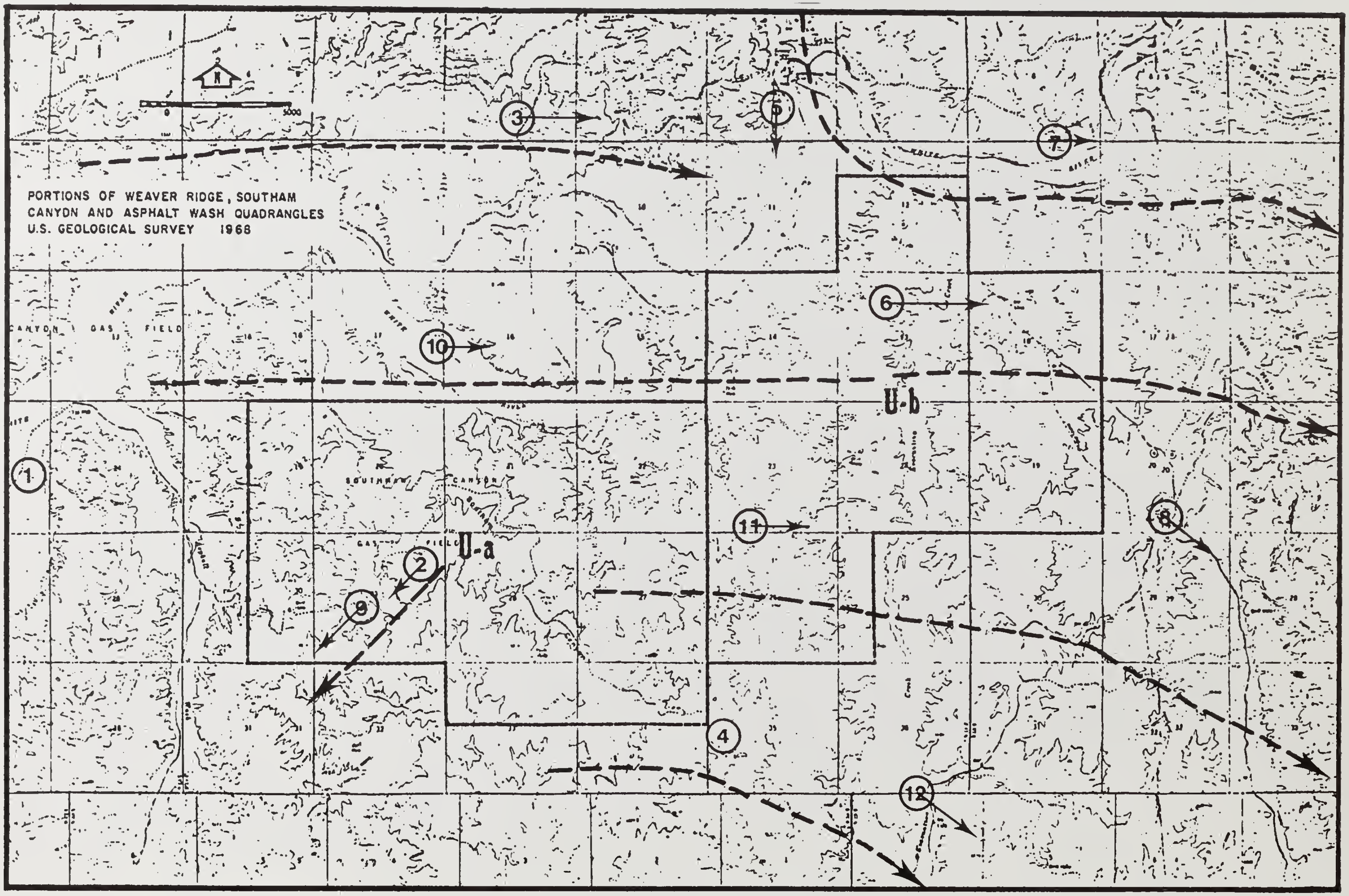
U-b
CANYON GAS FIELD
SOUTHAM CANYON
GAS FIELD
WHITE RIVER
Asphalt
Creek

5 m/s ⟶ Wind Vector

– – –⟶ Streamline

FIGURE III-16. Generalized surface flow pattern - early morning on 19 February 1975.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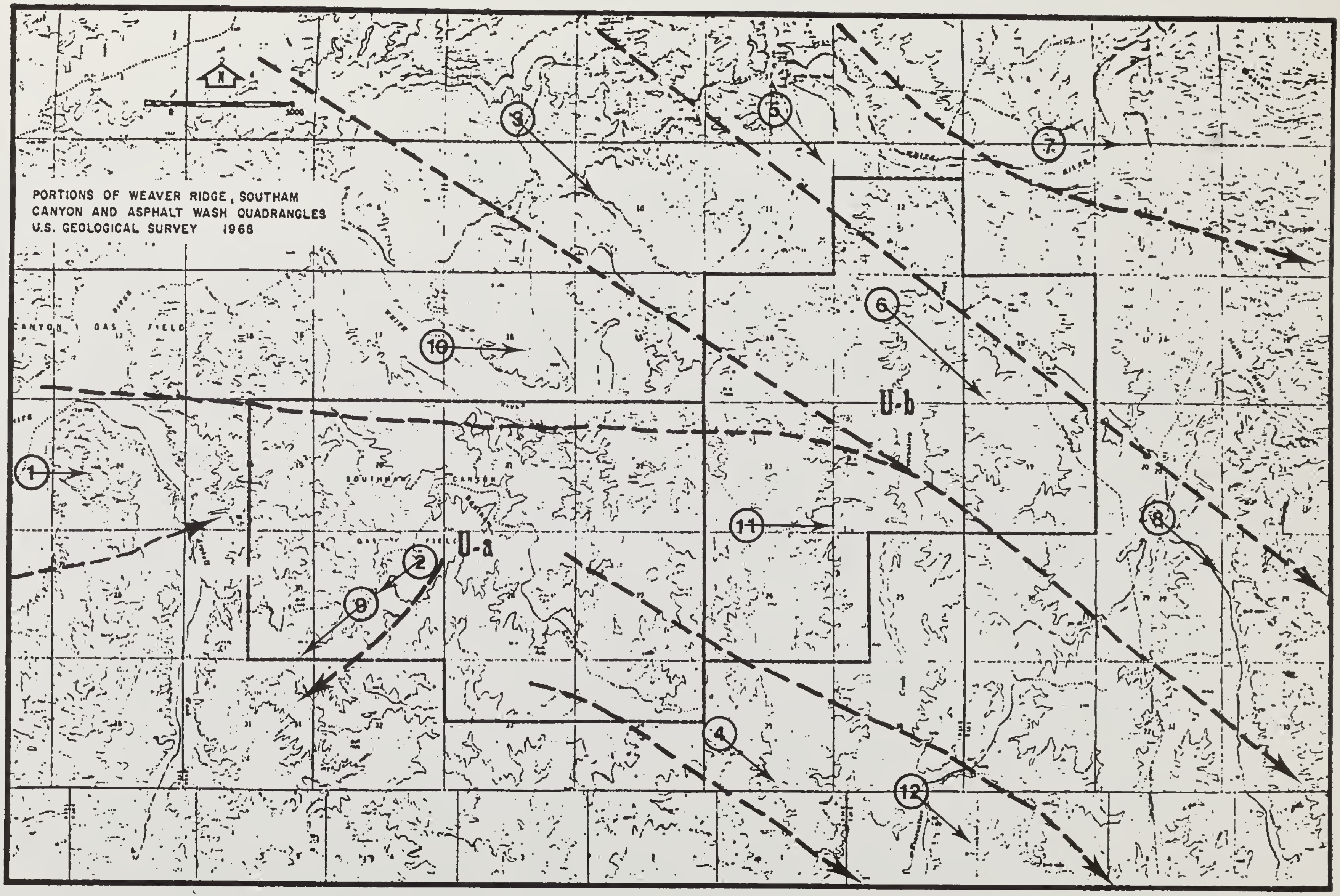
CANYON GAS FIELD
SOUTHAM CANYON
GAS FIELD
5 m/s
Wind Vector
Streamline

FIGURE III-17. Generalized surface flow pattern - mid-day transition on 19 February 1975.

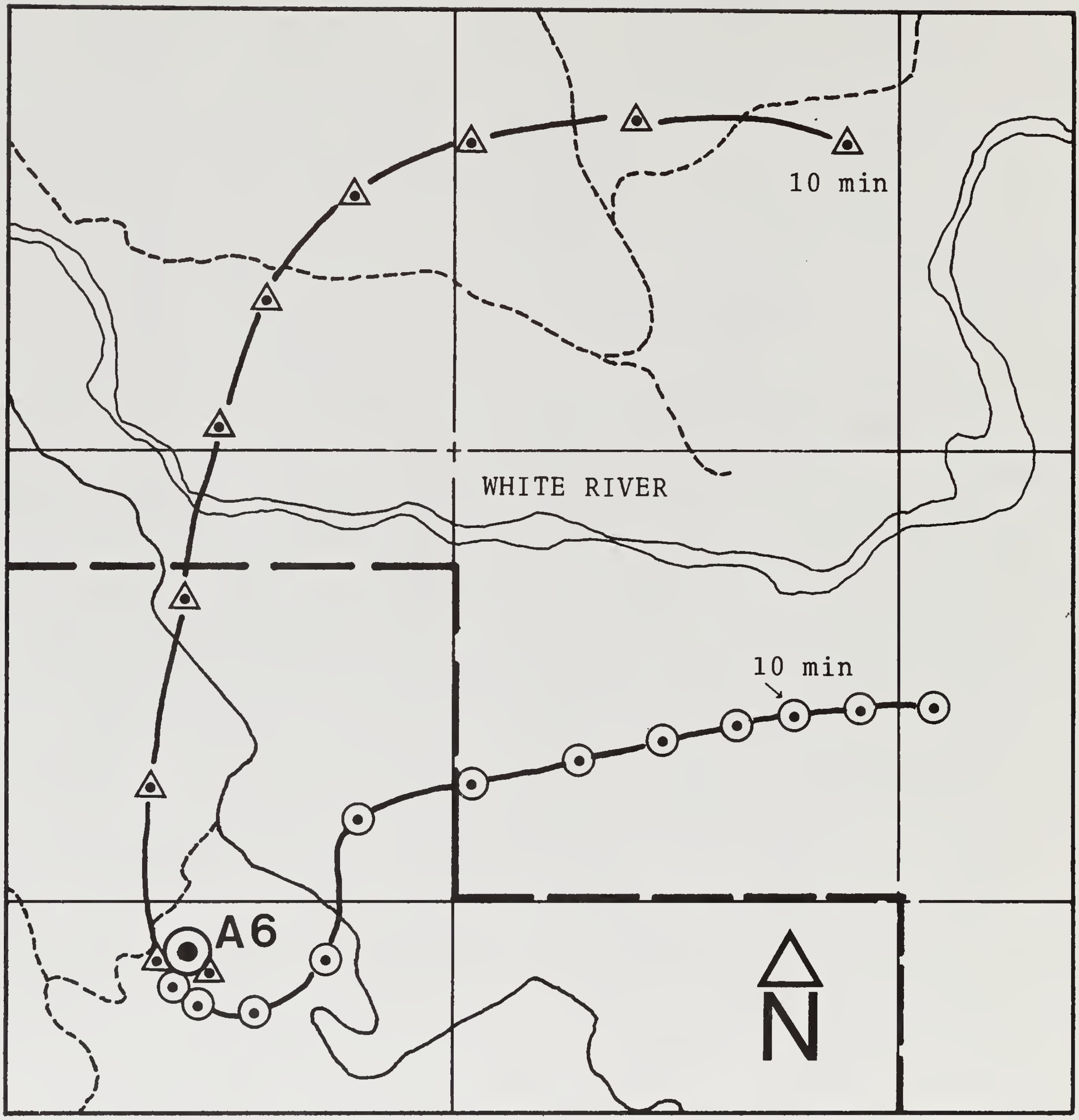


PORTIONS OF WEAVER RIDGE, SOUTHAM CANYON AND ASPHALT WASH QUADRANGLES U.S. GEOLOGICAL SURVEY 1968

5 m/s → Wind Vector

FIGURE III-18. Generalized surface flow patterns - afternoon on 19 February 1975.

---→ Streamline



⊙ PIBAL released at 1225 MST

△ PIBAL released at 1715 MST

FIGURE III-19. Trajectories of pibals released on 19 February 1975.

Temperature soundings on the morning of the nineteenth indicated a surface-based inversion 196 m thick with a strength of 1.8°C/ 100 m. This inversion persisted into the early afternoon and, in fact, its thickness increased to 286 m and its strength to 3.1°C/100 m by mid-day. By 1800 MST the inversion had been weakened to a shallow upper air inversion 59 m thick with its base with its base 250 m above ground level. This growth and decay of the surface-based inversion was vividly captured by the acoustic radar record presented in Figure III-20, on which the vertical temperature profiles obtained from rawinsonde soundings are superimposed. The acoustic radar chart shows a surface-based inversion in the morning. Its top was about 200 m AGL, with a change in inversion strength of about 100 m AGL. Inversion thickness decreased until 1000 MST and then increased steadily. This is contrary to normal diurnal variations, but corresponds very well with the approach of the low pressure system. As mentioned earlier, pressure started dropping at 0900 MST. Roots of thermals were apparent starting at 1430 MST. The activities of these thermals destroyed the lower part of the inversion so that by 1800 MST only a very shallow upper air inversion was left.

The surface weather situation on Feburary 21 was similar to that of the nineteenth. The early morning flow was again mainly drainage, and the surface-based inversion was about 130 m thick. No surface-based or upper air inversions were detected in the afternoon, however. Upper air flow was from the north throughout the day; pibals released at 0835 and 1217 MST traveled toward the south after the first few minutes of tracking. This northerly

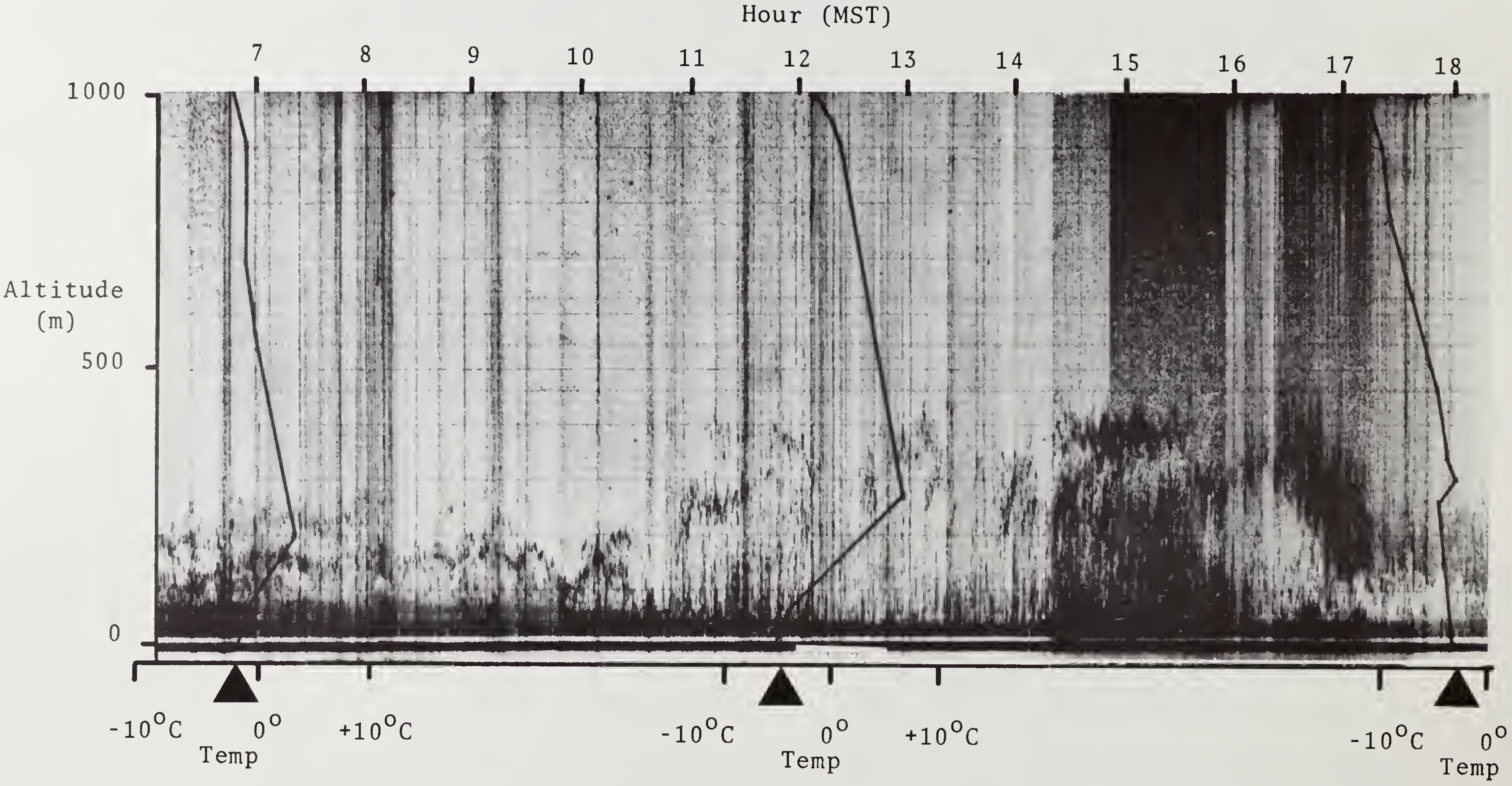


FIGURE III-20. Acoustic radar record for 19 February 1975, with rawinsonde temperature soundings superimposed. Times of soundings are indicated by the triangles.

upper air wind is an unusual phenomenon attributed to the synoptic scale disturbance associated with the low pressure system mentioned earlier.

Ozone and Particulate Distributions

The spatial distributions of ozone and particulate matter were measured by traverses along a triangular course from Vernal to Station A-6 to a point 25 km upwind of Station A-6 and then back to Vernal. At each vertex of this triangle, vertical soundings were performed from the surface up to 4300 m (14,000 ft) MSL at Station A-6 and the upwind point and up to 3000 m (10,000 ft) MSL at Vernal.

Low level ozone concentrations during the study period were in the 60-120 $\mu g/m^3$ (.03-.06 ppm) range. As shown in the early morning aircraft sounding records in Figures III-21 and III-22, the ozone concentration at Station A-6 was 0.04 ppm up to 2,800 m MSL, above which it was variable between 0.02 and 0.04 ppm; at Vernal, a little later, the surface concentration was just over 0.02 ppm at the surface and ranged between 0.04 and 0.05 ppm above 2,800 m. The temperature, turbulence, and scattering coefficient traces at Vernal all show the mixed layer to extend up to about 2,200 m, which is also the depth of the layer of low ozone values. Consequently, a probable cause for lower surface O_3 levels at Vernal than at Station A-6 is depletion of background O_3 in Vernal by reaction with NO emitted from heating equipment and motor vehicles.

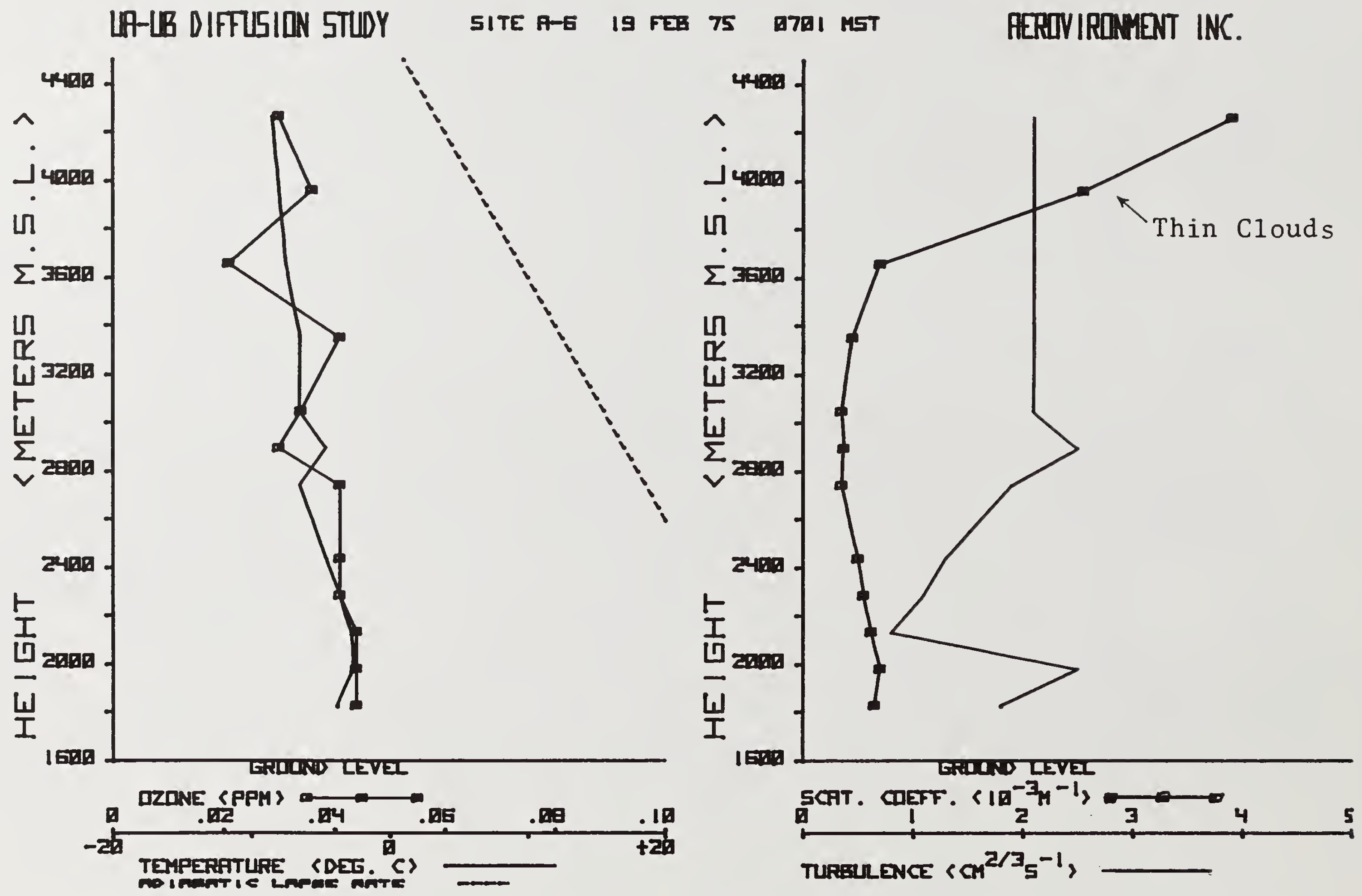


FIGURE III-21. Vertical profiles of ozone, temperature, light scattering, and turbulence above site A6 at 0701 on 19 February.

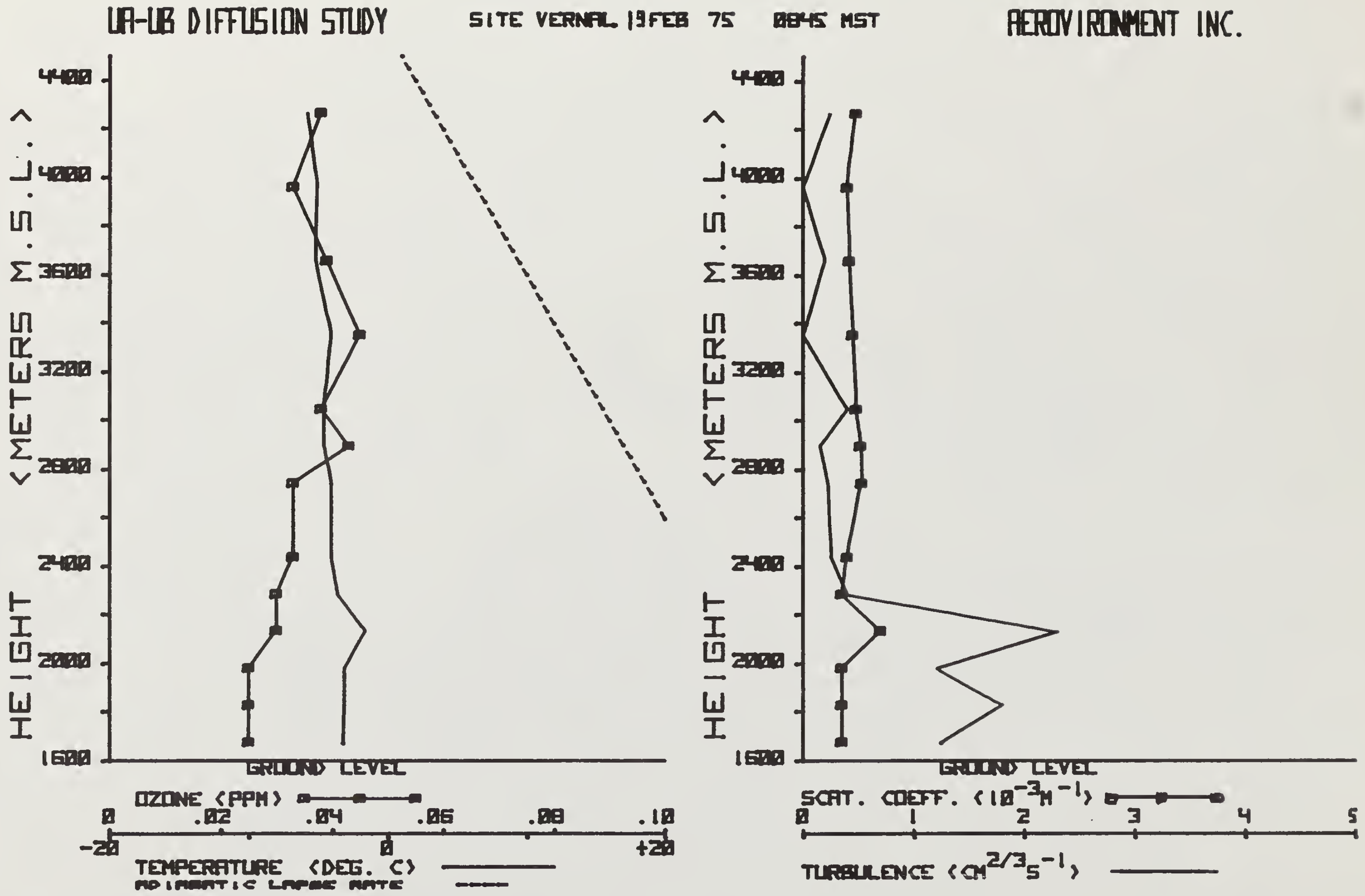


FIGURE III-22. Vertical profiles of ozone, temperature, light scattering, and turbulence near Vernal at 0845 on 19 February.

The same figures show comparable early morning mixing depths of about 400 m at both Station A-6 and Vernal; the Vernal layer was slightly thicker, possibly because of the later hour of the sounding. Particulate levels, as measured by light scattering, are essentially identical at both locations and show a slightly higher concentration toward the top of the mixed layer, especially in Vernal.

In comparison, late afternoon soundings at Station A-6 and Vernal are shown in Figures III-23 and III-24. The surface ozone levels have increased during the day to about 0.06 ppm at both locations and show a decrease with height to the previously observed upper air value of 0.04 ppm. The mixed layer is now deeper, and the turbulence trace at Station A-6 shows it extending to about 2,800 m MSL (1200 m AGL). It is considerably shallower (about 400 m deep) over Vernal.

The situation on the morning of February 21, after passage of the front on the twentieth, is shown in Figures III-25 and III-26. In Figure III-25, the temperature profile at Station A-6 shows stability but no inversion, the ozone and light scattering are constant with height, and there is light turbulence for the bottom 1,400 m. The situation in Vernal was somewhat different, however, as shown in Figure III-26. There the turbulence trace shows a shallow, well-mixed layer about 200 m deep with low pollution (ozone and light scattering) above it. The absence of an inversion results in higher dispersion than on the nineteenth, and ozone depletion is not observed.

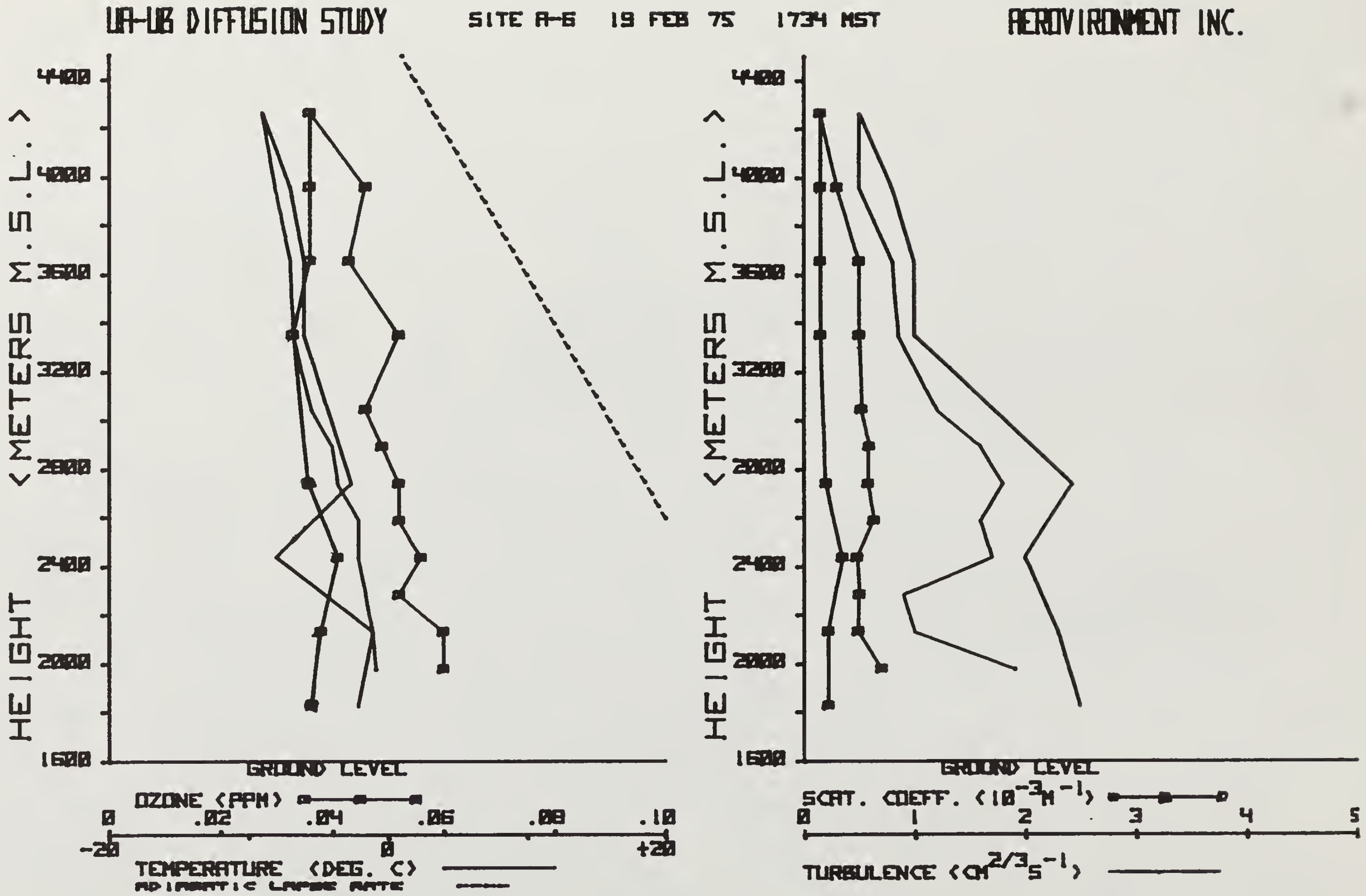


FIGURE III-23. Vertical profiles of ozone, temperature, light scattering, and turbulence at site A6 at 1734 on 19 February. The double traces indicate both ascending and descending measurements.

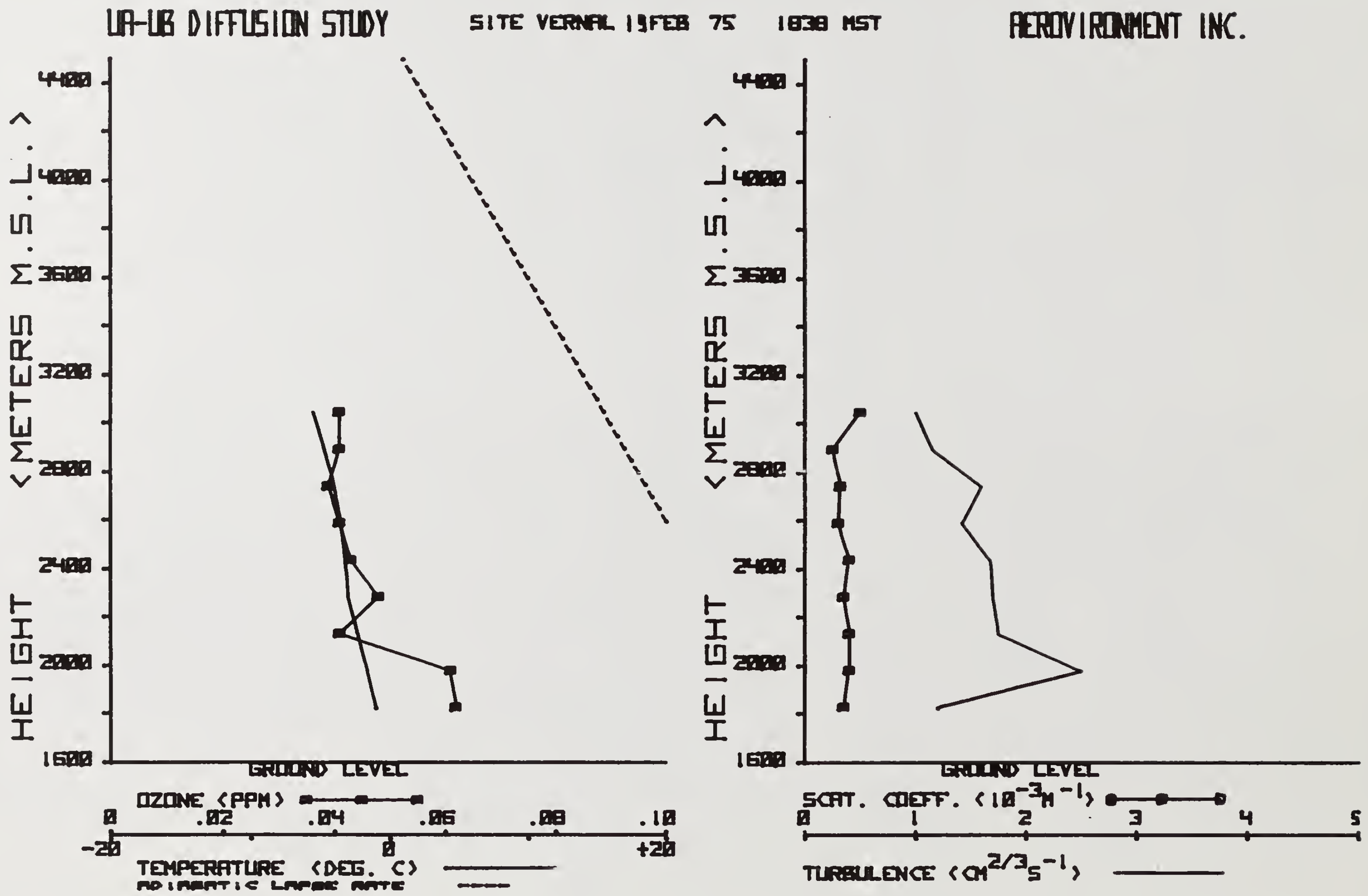


FIGURE III-24. Vertical profiles of ozone, temperature, light scattering, and turbulence near Vernal at 1838 on 19 February.

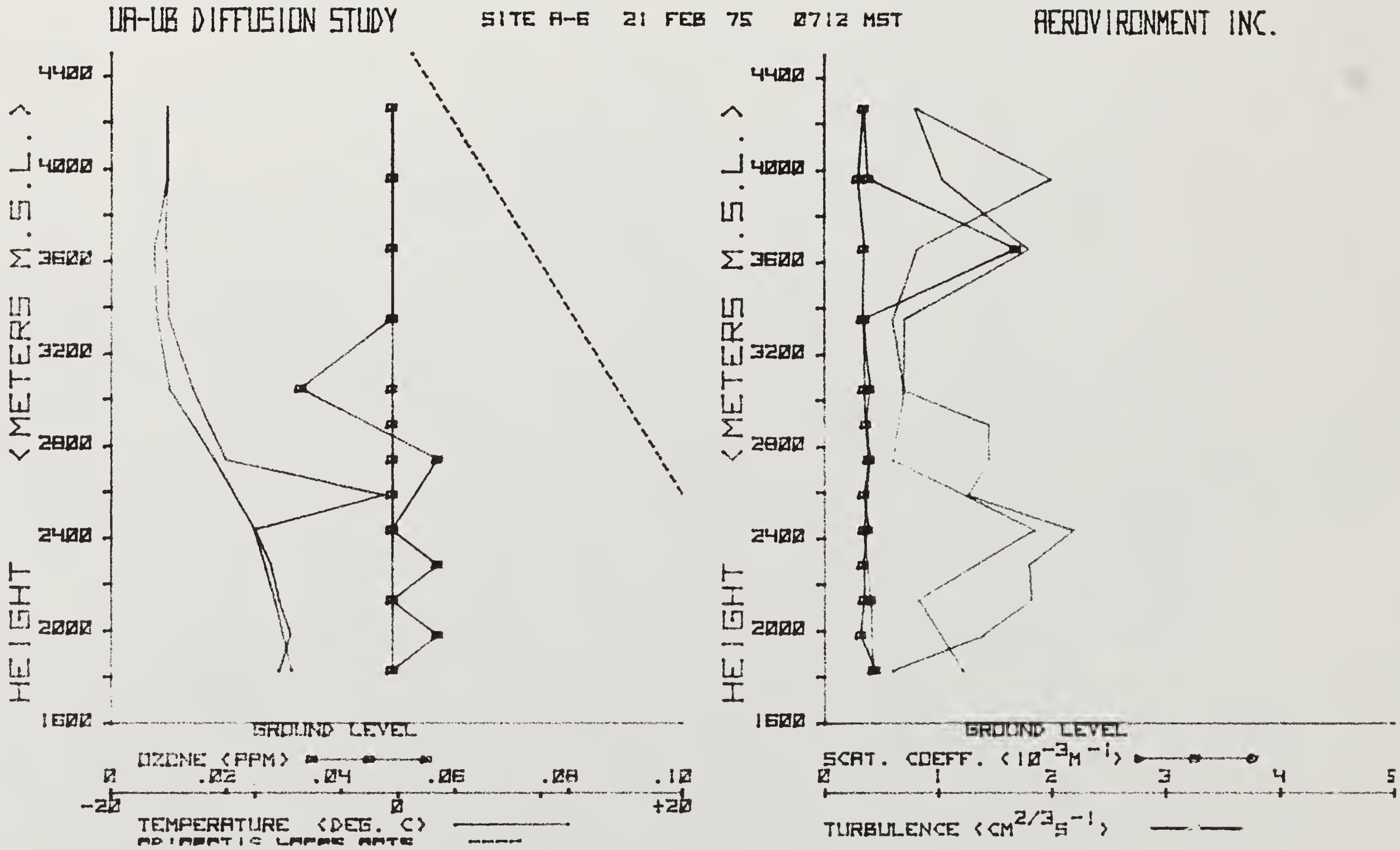


FIGURE III-25. Vertical profiles of ozone, temperature, light scattering, and turbulence at A6 at 0712 on 21 February. Double traces indicate ascending and descending soundings.

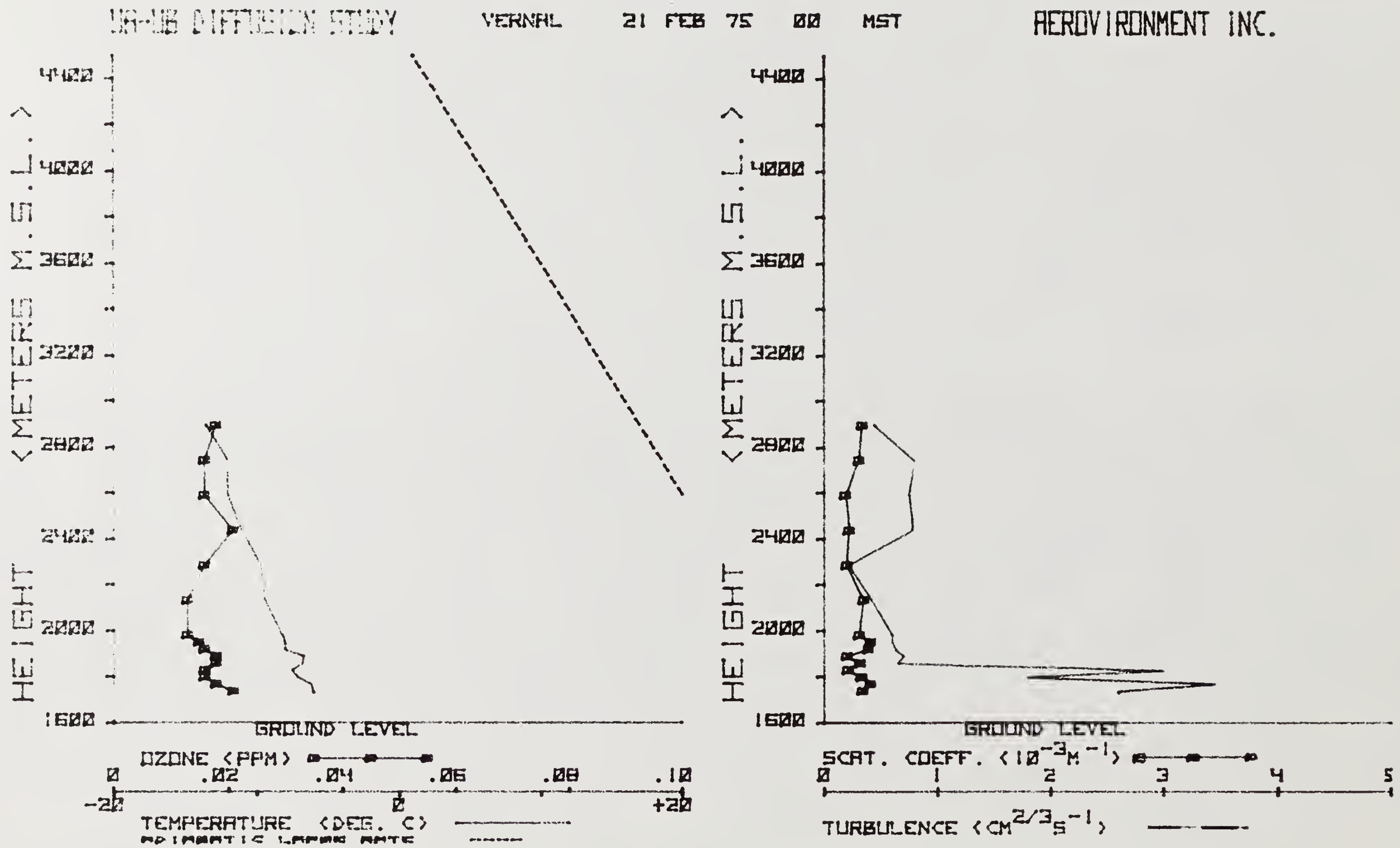


FIGURE III-26. Vertical profiles of ozone, temperature, light scattering, and turbulence near Vernal at about 0900 on 21 February.

From these soundings and data from the horizontal traverses throughout the area, a general picture emerges. Surface pollutant levels, in terms of ozone and particulates, showed no spatial variability with location, except for a highly localized ozone depletion over Vernal in the early morning hours of a very stable day. Vertical profiles of ozone show no major variation, again with the exception of localized effects over Vernal. Suspended particulate concentrations, which are to first order proportional to the light scattering coefficient, show slightly higher values near the ground and in the mixed layer than above, as would be normal. Diurnally, ozone increases during the daylight hours; there is no significant diurnal effect on particulates.

The rather low and uniform values of O_3 concentration did not indicate sources of the relatively high ozone values observed in the fall, which subsided during the winter and was at typical background levels at the time of the experiment. The absence of measurable spatial variability in the February experiments suggests that generation of O_3 from anthropogenic sources in the tract areas is not a mechanism. Since O_3 levels aloft were equal to, or less than, those near the surface (again with the exception of near Vernal), the upper atmosphere was not a source at other times of the year. If these high values were of stratospheric origin, then they would indeed be expected to show peaks in the spring and fall and, in fact, O_3 observations in other rural areas have shown this to be true. Only further study during the next year will show whether this trend occurs here also.

Smoke Diffusion and Transport

The smoke released from 90 m above Station A-6 at various times during the experiment was tracked by the aircraft, which crossed the cloud as long as it was visible to the eye. An integrating nephelometer on board recorded the smoke concentration through the cloud, and the data from each crossing was correlated with the age of the cloud and its position.

Smoke was successfully released at noon and 1700 MST on February 19 and at 0820 MST and noon on February 21. The two mid-day tests were both performed in moderately windy conditions with significant diffusion, so the cloud could be tracked only about 5 minutes on each day before it had diffused so much that it could no longer be seen.

The evening of the nineteenth and the morning of the twenty-first both exhibited very low dispersion. In both of these cases the plume was tracked for more than 30 minutes and more than 20 aircraft crossings were accomplished. The cloud was still quite visible when the crossings were terminated because sufficient data had been acquired. In dramatic contrast to the calm conditions on the evening of the nineteenth, the test on the evening of the twenty-first had to be canceled because high winds broke all of the smoke system support balloons.

The trajectories followed by the smoke cloud on three of the four tests are shown on Figure III-27; the noon run on the nineteenth is missing from the plot, but was very similar to the noon run on

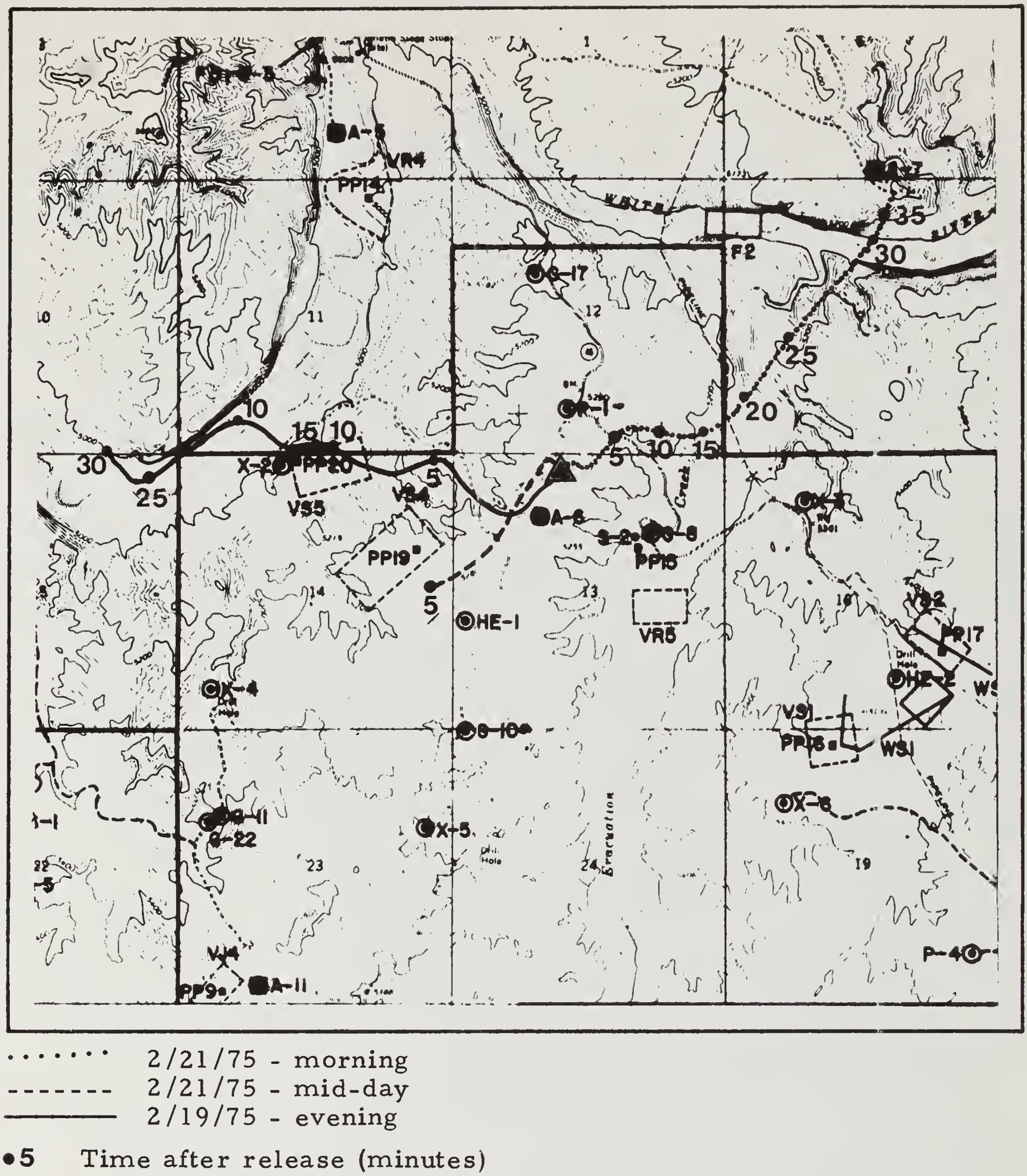


FIGURE III-27. Trajectories of three smoke clouds released at 90 m above A6 on 19 and 21 February.

the twenty-first. The varied directions of travel of the cloud at various times of the day are clearly shown here. Of special interest is the difference between the westward direction traveled by the cloud on the afternoon of the nineteenth versus the generally eastward (westerly) surface flow prevailing then, as shown on Figure III-18. During calmer conditions great variability in wind direction with small changes in elevation was common; Figure III-19 shows this: the afternoon pibal originally headed eastward, turned westward (as did the smoke), ascended to a level where it headed northward, and finally reached an upper level flow which took it eastward.

The integrating nephelometer in the aircraft crossing the plume recorded smoke concentration profiles similar to those in Figure III-28. The three profiles for cloud ages of 7, 14, and 28 minutes--show the steadily decreasing concentration in the cloud and the steadily increasing cloud size. The irregular nature of diffusion is also apparent.

To gain useful information about diffusion on the tracts from such profiles, this decay and spreading was quantitatively analyzed. To explain this analysis procedure, a brief digression into some of the fundamentals of diffusion theory is necessary. This is complicated because there is still no accepted basic theoretical model for the growth of a puff. An acceptable theoretical analysis, based on the concept of the Kolmogrov similarity theory and given by Pasquill in his classic book Atmospheric

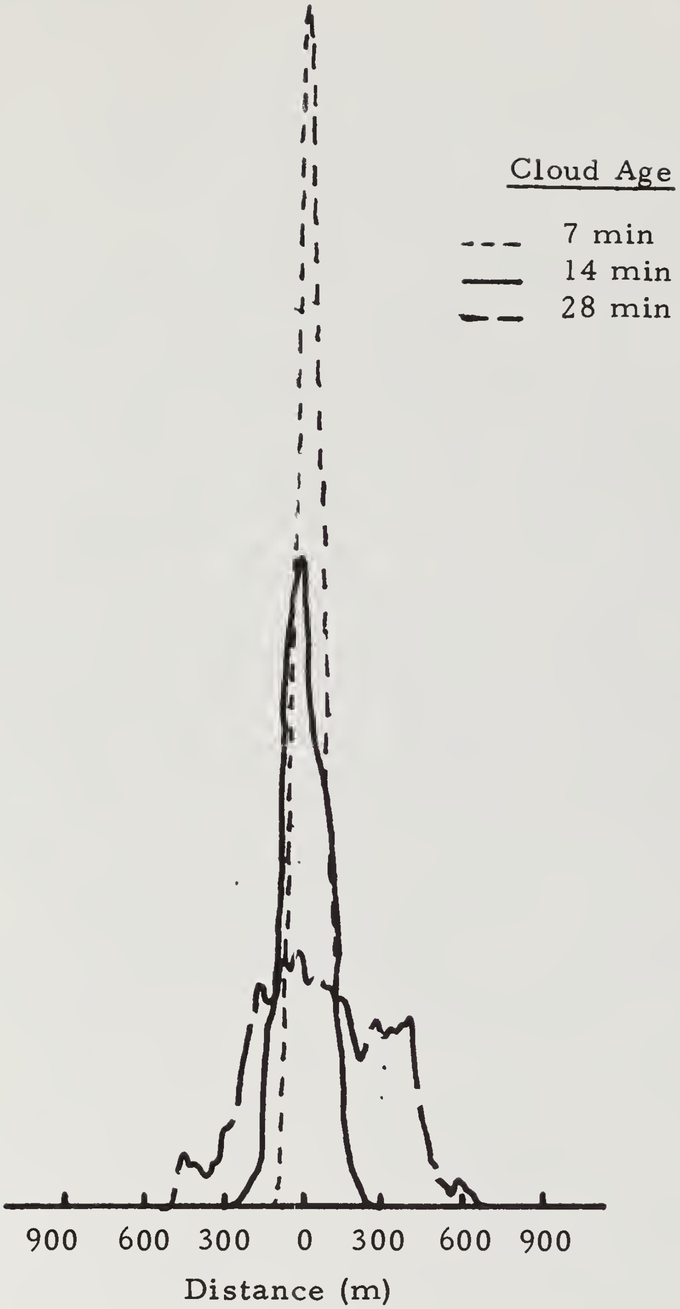


FIGURE III-28. Plume cross sectional profiles on the evening of 19 February.

Diffusion, is that the mean width of a puff $(\overline{y^2})^{1/2}$ obeys different laws for short and long times. For short times $(t \ll t_L)$ the expression is

$$\overline{y^2}(T) - \overline{y^2}(0) \sim t^2$$

where $\overline{y^2}(0)$ is the initial puff size and t_L is the Lagrangian time scale which must for the moment remain undefined.

For intermediate periods, the growth is somewhat more rapid, corresponding to interaction with turbulence of larger length scales, and goes like

$$y^2(t) \sim t^3$$

For very long periods, $t \gg t_L$ the usual Fickian diffusion is believed to obtain so that the puff grows more slowly with time and we get $y^2(t) \sim t$. Pasquill presents experimental data giving reasonable support to these growth laws.

To use this experimentally derived dispersion data from these experiments to estimate peak concentrations, the equation for concentration χ at the center of the puff is utilized

$$\chi = Q/(2\pi)^{3/2}\,\sigma^3$$

where Q is the initial mass of contaminant and σ is the "width" of the puff (in the same sense in which σ is the width of a Gaussian distribution curve). This relation is totally defined for a given source strength Q if the puff size σ is known.

Figures III-29 and III-30 display the measured cloud widths, σ, and "concentrations" (expressed as scattering coefficient, b_s) for the two low dispersion smoke observation periods on the evening of the nineteenth and the morning of the twenty-first. These plots show that the cloud starts out initially (at $\tau \sim 10$ sec) with a width of about 100 m, grows very slowly initially until about $t = 400$ sec. After that, on the evening of the nineteenth, the growth becomes more rapid (approximately as $t \sim 3/2$) while a slow growth continues on the test of the morning of the twenty-first.

The concentration profiles, expressed in terms of the scattering coefficient, b_s, have a corresponding behavior, with little decay in concentration until $t = 400$ sec, after which the rate of decay rapidly increases and becomes faster than $1/t^2$.

These decay and growth rates, although not wholly consistent with any of the theoretical formulations, suggest that a transition to the long-time behavior is taking place.

From this one can conclude that the Lagrangian time scale is much less than 400 seconds, say roughly 100 seconds. For the approximately 2 m/s puff transport speeds, this means that the Lagrangian turbulence scale L is about 200 m, a reasonable number for these conditions.

Thus one can now use a simple formula of the form

$$\chi/Q = \frac{1}{2.76\, L \sqrt{\sigma_v \sigma_w}\; x}$$

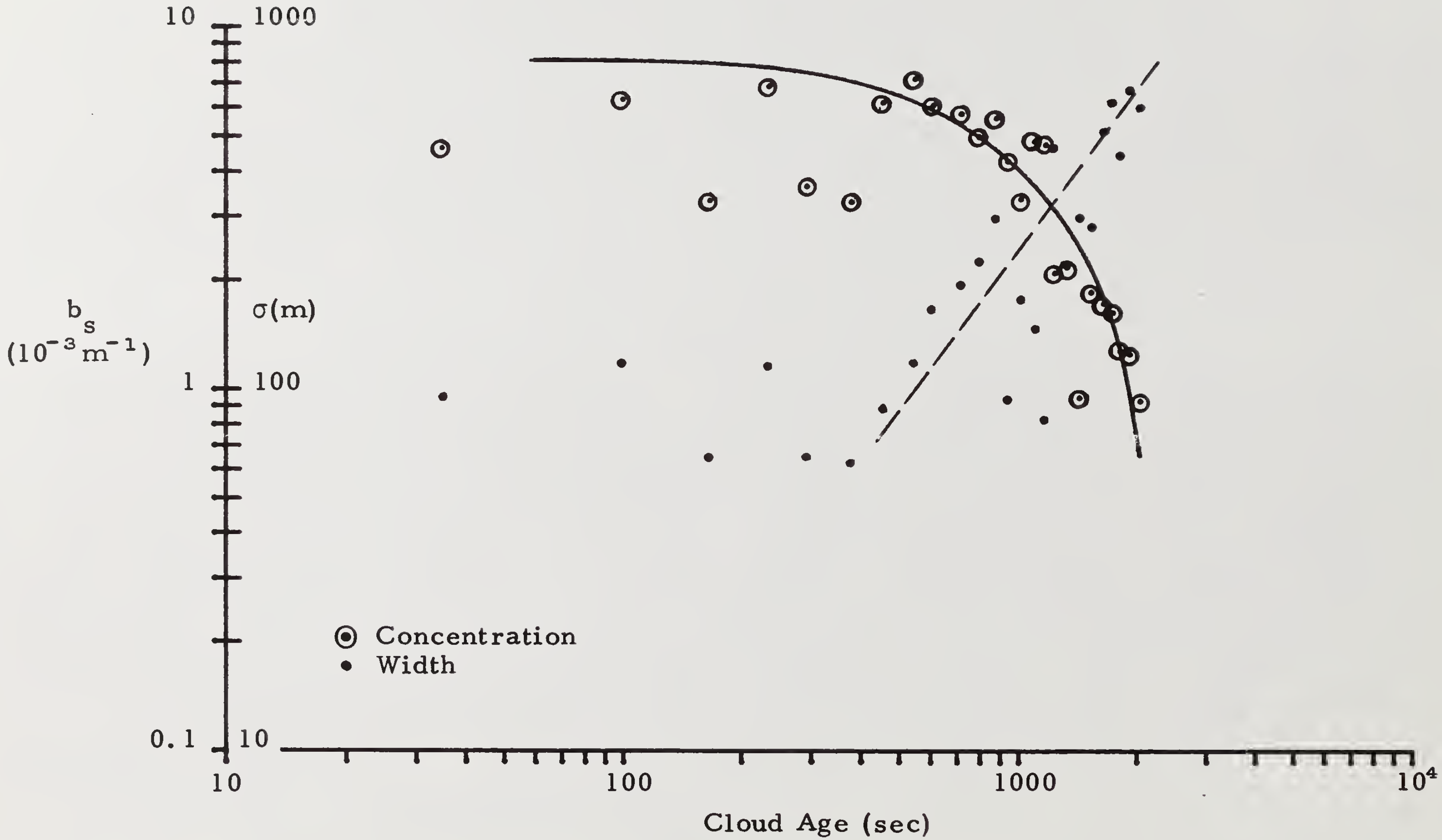


FIGURE III-29. Cloud width and concentration history for the evening of 19 February.

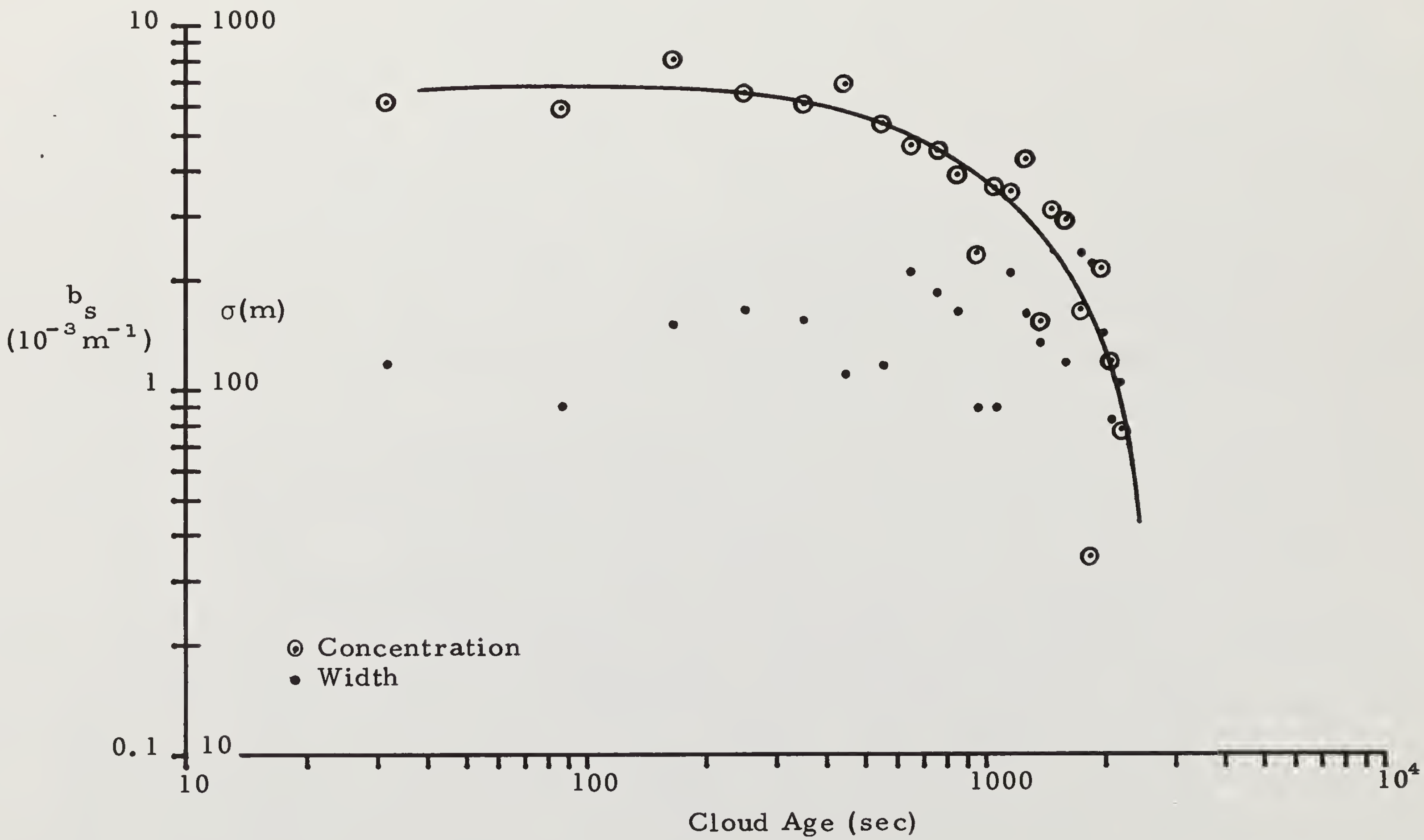


FIGURE III-30. Cloud width and concentration history for the morning of 21 February.

where X is the downwind distance, to estimate the centerline concentration in a plume from an elevated source which emits continuously at a rate Q. As an example, previously the value of $(\sigma_v \sigma_w)^{1/2}$ of 0.55 m/s was given for an average April morning at A6. Using this value, and the value of L just determined for a source at A6 at 90 m above the surface, χ/Q at $x = 1$ kilometer is estimated to be 0.3×10^{-5} s/m^3. This value was estimated based on very calm atmospheric conditions. Similar estimates can be made for other situations and, using more complex equations, to estimate surface concentrations. To do so here would be only an exercise, however, since source configurations need to be accurately defined for meaningful results.

As an alternative, χ/Q for a puff can be computed from Figures III-29 and III-30. For example, at t= 500 seconds the cloud will have traveled 1 km if the wind speed is 2 m/s. At this time on the evening of the nineteenth the data gives $\sigma \sim 100$ m, so the equation given earlier in this discussion.

$$\chi/Q = 1/(2\pi)^{3/2} \sigma^3$$

gives $\chi/Q \approx 0.1 \times 10^{-6}$ m^{-3} 1 km. Since this computation is for a puff, which diffuses in three-dimensions, it should be smaller than the previously given value for a plume; this is indeed the case.

This again is a result for extremely calm conditions. A more typical situation would result in a considerably smaller value χ/Q. As an example of this, the atmospheric turbulence measured by the aircraft while probing the clouds in both of the cases under consideration was approximately of the intensity $\epsilon^{1/3} \doteq 1\text{-}1.5\ \mathrm{cm}^{2/3}\mathrm{s}^{-1}$, while during the two noon runs it was at about twice that level. Since $\sigma_v\sigma_w \sim \epsilon$, this means that χ/Q for the puff would have been about one-fifth of the morning value, while for a plume it would have been about one-third of the morning value.

Use of estimating techniques such as these will permit an eventual categorization of diffusion conditions on the tracts in terms of time of day, season of year, and location. Because of the complex topography, normal categorization techniques such as those by Pasquill are not applicable; thus, a unique construction especially for the tracts is required. Work on such a categorization, which will rely on additional experiments of the type discussed here, is under way.

C. WORK SCHEDULED

In addition to routine continuous monitoring of air quality and meteorological parameters, the next quarterly report period will include some other regularly scheduled activities and one special experiment.

Regularly scheduled measurements of a periodic nature include a sound level survey in July and monthly visibility measurements. Continuous recording of radiation dosage through simultaneous thermoluminescent dosimetry at all 12 air sites on the tract will commence in June and become a regular measurement procedure from then on.

A second diffusion experiment will be held during the week of June 16-20, and will include diffusion characterization at Station A-6 and at another location on the tracts. A special demonstration of the experiment is scheduled for the OSEAP during its tour of Tracts U-a and U-b on June 19.

Comprehensive data analysis will continue, with increasing emphasis on concise characterization of baseline conditions on the tracts during the first year of monitoring. A simple representation of atmospheric diffusive properties is also being prepared and will depend heavily on the results of the two diffusion experiments. A complete characterization and interpretation of all radiation results should be possible on completion of the radioactivity analyses of oil shale samples taken from the X2 drill core in December. The samples are being analyzed by the EPA laboratory in Las Vegas, with completion expected late in July.

TABLE III-9

METRIC TO ENGLISH CONVERSION FACTORS

Given	Conversion Factor	Converted to
Degrees Centigrade	1.8°C + 32	Degrees Fahrenheit
microgram	15.4124×10^{-6}	grains
kilometer	62.137×10^{-2}	miles
millimeter	3.937×10^{-2}	inches
meter	32.808×10^{-1}	feet
meters per second	2.2369	miles per hour

micrograms per cubic meter	(@ 25°C 760 mmHg)	parts per million (vol	
1 $\mu g/m^3$ O_3	=	0.51×10^{-3}	ppm
1 $\mu g/m^3$ NO_2	=	0.00053	ppm
1 $\mu g/m^3$ NO	=	0.0008	ppm
1 $\mu g/m^3$ SO_2	(@ 0°C 760 mmHg) =	3.5×10^{-4}	ppm
milligram per cubic meter	(@ 25° 760 mmHg)		
1 mg/m^3 CO	=	0.87	ppm

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nanogram = 10^{-9} gram

microgram = 10^{-6} gram

milligram = 10^{-3} gram

1 picocurie = 10^{-12} Curie = 1 μμCi

1 Curie = 3.7×10^{10} disintegrations per sec

12Z (ZULU, GMT) = 5:00 AM MST (Mountain Standard Time)

IV. BIOLOGICAL RESOURCES

A. WORK COMPLETED

1. VEGETATION

Data collected last fall was interpreted and statistically analyzed. Phenological, soil moisture, and temperature data were collected in March, April, and May at the 20 previously established plots. Nearly 1,000 plants of six native shrub species were transplanted at four drill sites in April.

2. TERRESTRIAL VERTEBRATES

The Fish and Wildlife Management plan was completed and approved by the Area Oil Shale Office (AOSO) for distribution to the Oil Shale Environmental Advisory Panel (OSEAP). Considerable effort was directed towards monitoring deer movements and determining areas of deer use on the tracts. On-ground surveys were conducted regularly through March and April. An attempt was made in March to bait deer into selected areas with alfalfa hay and apples, but it was not successful because of the widely dispersed deer population and number of sheep present. The last sheep herd left the tracts April 22, and in the succeeding week deer began appearing regularly along the White River. It was determined that sufficient numbers were available to warrant a drug-capture program.

During the first week in May, six deer were captured and fitted with radio transmitters and color-coded collars. An additional animal was collared May 23. The animals were located along the White River and approached by helicopter. They were then immobilized using pre-measured dosages of Succostrin in dry-darts fired from a Cap-Chur gun.

Two transmitter collars were constructed in May to be placed on additional deer when possible. Also, five coyote-bobcat collars were constructed and tuned. These will be used to monitor these species in June.

Areas of raptor use were studied intensively. Possible and existing nesting sites were mapped and sightings recorded.

Waterfowl populations were monitored by three canoe and raft trips on the White River. It was noted that beaver populations on the White River were very high, but no index was used to determine present populations.

The rodent bimonthly sampling program was completed in April. During this period it became apparent that some modification of the sampling schedule should be made. Rodent mortality from exposure was still too high to conduct an extensive trapping program; therefore the sampling schedule specified in the terrestrial vertebrate section of the Partial Exploration Plan should be changed in three respects: (1) The reptile and amphibian transects should be conducted only in times of significant activity. (2) The rodent trapping transects should be conducted only in April, June, August, and October. (3) The rodent trapping grid should be operated only in August. The latter will still provide an estimate of rodent density and will permit validation of the rodent trapping transects. A request will be made to the AOSS for program modification.

Data obtained from the sampling procedures (see Biological Field Data) were reduced and summarized, and species were tabulated by sampling site and sampling period.

3. TERRESTRIAL INVERTEBRATES

Several of Dr. Bohart's field trips were cancelled because of stormy weather. One trip was taken from May 13 through 15, primarily to gather samples of litter from beneath trees and shrubs. Sixteen samples were taken from beneath Amelanchier, Populus, Rhus, Elmatis, and Tamarix. Also taken were three samples of moss and a sample of litter deposited by flood waters in Evacuation Creek.

4. AQUATIC BIOLOGY

Work consisted primarily of bimonthly field collection and laboratory analyses. The lease area was visited from March 31 to April 11, 1975, between ice-melt and the beginning of spring runoff. Discharge during the period averaged about 350 cfs and river conditions were excellent for sampling. Quantitative and qualitative samples were collected at each station and analyzed according to the study outline.

All sampling procedures were effective with the exception of the multiplate periphyton samplers: some were buried in silt and others were apparently carried away by ice and debris. A new floating sampler was designed and placed in position at each station May 26. These samples will be recovered and analyzed during the June field study period.

Laboratory analyses were conducted according to the study plan. Data were recorded on forms developed for recording and calculating diversity data. A sample copy of the form is shown in Table IV-1.

During April, five Surber collections were made at each invertebrate station. Several were unusable because of inadvertent contamination, spoilage, loss, etc. The number of collections will be increased to six if possible. Station F-1 has few suitable sites for Surber sampling so other methods of collection will be used at that station.

Incidental work during the quarter consisted of preparing a regional description of aquatic biology and literature search of specific keys.

5. MICROBIOLOGY

Four sampling stations were established and soils were collected in four collection periods and analyzed.

Four sampling stations were established near existing soil survey pits 55, 50, 39, and 58. Station 39 was located near soil survey pit 39, west of Evacuation Creek, 2 miles south of the White River. The dominant vegetation at this station is big sagebrush and black sagebrush, (_Artemisia tridentata_ and _Artemisia nova_,

TABLE IV-1

MACROINVERTEBRATE LAB WORKSHEET

Project NO. 1517-17

Station No. F-3   Sample No. 2   Sampling Method Surber   Collection Date IV-1-75

ORDER	FAMILY	GENUS	SPECIES	NUMBER IN SAMPLE	CODE NO.
Ephemeroptera	Heptageniidae	*Heptagena*	*elegantula*	3	1
		Rhithrogena	*undulata*	6	6
	Baetidae	*Baetis*	*bicaudatus*		15
		Callibaetis			
		Ephemerella	tibialis	4	33
		Trichorythodes	*minutus*		36
		Lachlania			
		Traverella	*albertana*		27
Odonata	Gomphidae	*Gomphus*	*intricatus*		43
		Ophiogomphus	*severus*		45
	Libellulidae				
	Aeschnidae				
Plecoptera	Perlodidae	*Isogenus*	frontalis (?)	2	25
		Arcynopteryx	Sp. A	1	27
	Perlidae	*Taenionema*	*pacifica*		65
		Acroneuria			
Trichoptera	Hydropsychidae	*Hydropsyche*	Sp. A	1	95
	Limnephilidae				
	Brachycentridae	*Brachycentrus*			
Hemiptera	Mesoveliidae	*Mesovelia*	*mulsanti*		81
	Gerridae				
Coleoptera	Dytiscidae	*Agabus*			
	Elmidae				
Diptera	Simuliidae				
	Culicidae				
	Chironomidae	Chironomus	Sp. A	2	130
		Stictochironomus	Sp. A	2	132
	~~Ceratopogonidae~~	Genus a		28	134

TOTAL 49

Biologist   Total Number of Taxa 9 $\bar{d} = 2.20$

respectively). Station 50 J was located some distance from pit 50 located within Southam Canyon, 2 miles south of the White River. The principal vegetation at this station includes black sagebrush and juniper (*Juniperus osteosperma*).

Another sampling station was located near pit 55 in a site dominated by mixed riparian vegetation and located south on the White River, 1 1/2 miles west of Evacuation Creek. A sampling station was located near pit 58, within Southam Canyon, 1/2 mile from the White River. Dominant vegetation is black sagebrush and greasewood (*Sarcobatus vermiculatus*). Depths of samples taken for the four soil stations are identified in Table IV-2.

B. DATA SUMMARY

1. VEGETATION

In late summer 1974, four vegetation types (saltbush, juniper, sagebrush - greasewood, and riparian) were delineated on the oil shale lease sites. Within each vegetation type five separate sites were inventoried to measure apparent differences within each vegetation type. Four plant attributes (height, cover, density, and production) were determined for each species occurring in 20 4-m^2 plots placed randomly in each site. (Figure IV-1). The data presented here represent 400 plots (four vegetation types x five sites x 20 plots) inventoried during September 1974.

These data were analyzed statistically to determine means, 90 percent confidence interval (C.I.), and necessary sample size (number of plots) for each attribute measured for each species

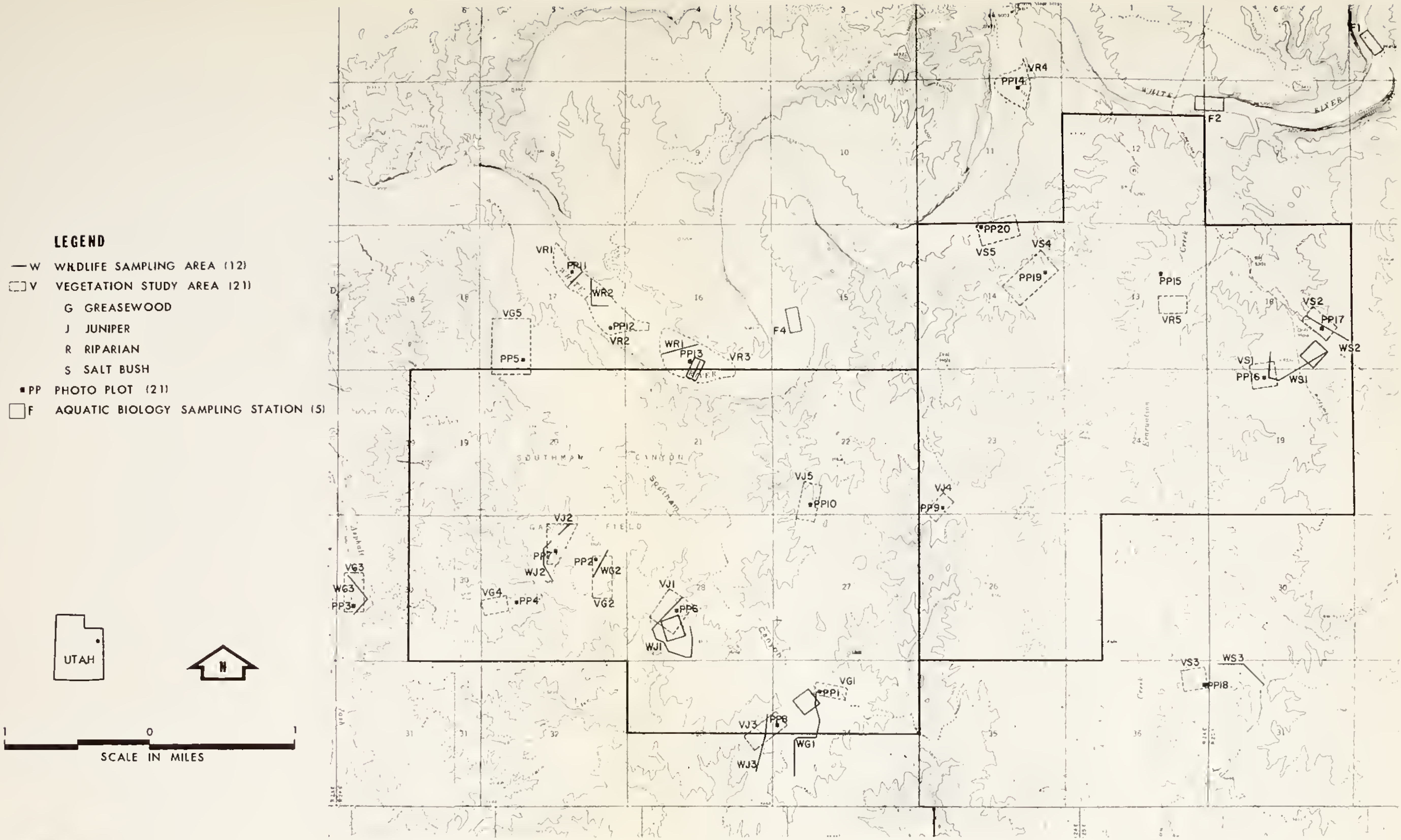
TABLE IV-2

SOIL MICROBIOLOGY SAMPLE DESIGNATIONS

Sample Designation	Depth of Sample
39-1	Surface to 3 cm
39-2	5-20 cm
39-3	40-50 cm
50J-I-1	Surface to 3 cm, interspace
50J-I-2	5-20 cm, interspace
50J-L	Surface=litter beneath canopy
50J-C-1	2-4 cm, beneath canopy
50J-C-2	4-15 cm, beneath canopy
55R-1	Surface to 3 cm
55R-2	5-20 cm
5BR-3	40-50 cm
58-I-1	Surface to 3 cm, interspace
58-I-1	Surface to 3 cm, interspace
58-I-2	5-20 cm, interspace
58-I-3	40-50 cm, interspace
58-C-1	Surface to 3 cm, beneath canopy
58-C-2	5-20 cm, beneath canopy
58-C-3	40-50 cm, beneath canopy

Note:

J = Juniper
I = Interspace or open space
L = Litter
C = Canopy
R = Riparian



BIOLOGICAL RESOURCES PROGRAM

FIGURE IV-1

encountered. Two computer runs were made. In the first run, analyses were done by site in each vegetation type. The second computer run consolidated data from all sites in each vegetation type. The analysis used determined the means, C.I., and sample size for each attribute by species. These data apply to plots where the species were observed. These data were later converted to give an estimate of mean height, cover, density, and dry matter for each species in each vegetation type.

Species inventoried in September 1974 do not represent the total species composition because some species did not occur in the plots and some species were not evident during the sampling period. A botanical collection will be used to make a complete species list for the oil shale lease sites.

Height, cover, density, and production are subject to change on an annual basis because of variable environmental conditions, especially precipitation. Simple changes in aspect (slope, exposure, etc.) can effect changes over a short distance. Grazing or other disturbances can also affect changes. The chosen attributes of the vegetation in each vegetation type provide a baseline characterization which may be used to detect changes in plant condition over a period of years with an adequate sampling program.

The sagebrush - greasewood type has no tree canopy cover. Only about 16 percent of the surface is covered and 10 percent of this cover is litter. Dominant species such as Russian thistle (*Salsola kali*), greasewood (*Sarcobatus vermiculatus*), and big sagebrush (*Artemisia tridentata*) each provide about 1 percent of the ground cover and the remaining 3 percent is covered with various other species. In this vegetation type an average of 39 Russian thistle plants and six shadscale (*Atriplex confertifolia*) shrubs occur in each 4-m^2 plot. Big sagebrush (*Artemisia tridentata*), black sagebrush (*Artemisia nova*), and Indian ricegrass (*Oryzopsis hymenoides*) occur about once in each plot and about five *Stipa comata* plants occur in each 4-m^2 plot. Initial measures of production show that Russian thistle and greasewood account for most of the current year's production.

Juniper (*Juniperus osteosperma*) is obviously the dominant species in height and general appearance in the juniper vegetation type. Twelve percent of the ground is covered by litter; 1 percent, by black sagebrush; and 12 percent, by a juniper overstory. About 85 percent of the surface is bare ground. Litter and juniper canopy overlap considerably as surface cover. *Hillaria jamesii* is the most frequently encountered species with an average of nine plants per plot. Several other species occur one to four times in a plot, including black sagebrush, one of the major sources of plant cover. *Hillaria jamesii* provided much of the understory production in 1974.

In the saltbrush type, 90 percent of the ground surface is bare and litter covers only 1 percent. Black sagebrush, big sagebrush, and shadscale cover 7 percent of the surface, and the remaining surface is covered by several less dominant species. There is no canopy cover in this vegetation type. An average of 11 halogeton (*Halogeton glomeratus*) plants and 14 Russian thistle plants were encountered in each plot. Several shrubs occur on an average of one to four times in each 4-m^2 plot, including the shrubs which account for most of the live plant cover. Big sagebrush, black sagebrush, horsebush (*Tetradymia spinosa*), and greasewood account for a large portion of the current year's production.

The riparian vegetation type has only 21 percent bare ground, contrasting with the 84 to 90 percent bare ground encountered in the other vegetation types. Sixty-one percent of the surface is covered by litter. Five percent of the ground cover is saltcedar (*Tamarix pentandra*), 4 percent is rabbitbrush (*Chrysothamnus* spp), and 1.5 percent is greasewood. The remaining surface is covered by a variety of less dominant plants. Cottonwood trees (Populus fremontii) provide canopy over about 12.5 percent of the ground surface. In this vegetation type, saltgrass (Distichlis stricta), equisetum (Equisetum arvense) and greasewood were encountered most frequently in the 4-m^2 plots. The understory production is dominated by saltcedar, rabbitbrush, and greasewood. Cottonwood provides much of the litter.

The sample sizes necessary for a 90 percent probability of an observation falling within the range $\bar{x} \pm 0.25$ standard deviation are presented in the Field Data Report. In this initial sampling, enough plots were inventoried to adequately sample height and usually density, but cover and dry weight were seldom adequately sampled. Cover and production by species is highly variable over each vegetation type and the likelihood of adequately sampling these attributes is low, given the constraints of time and funds.

It is important to note that bare ground (total area - litter - plant cover) was sampled adequately and provides a useful baseline characterization of total cover. From watershed standpoint, the amount of bare ground is important. The riparian sites average about 22 percent bare ground while the other three vegetation types are 84 to 90 percent bare ground.

Subsequent measurements of the four vegetation attributes may differ by climatic conditions and the time in each species' life cycle that measurements are taken. In September many 1974 annuals were already part of the litter while in the spring they were part of the live plant component.

2. TERRESTRIAL VERTEBRATES

a. Reptiles and Amphibians

The month of April was much colder and wetter than usual in northern and eastern Utah and Spring was judged to be two to three weeks later than normal. The cooler temperatures, averaging between 20°C (68°F) at 1400 hours to -15°C (5°F) at 0600 hours were not conducive to the emergence characteristics of reptiles or amphibians. Most observations of lizards and snakes came on the last week of April as temperatures started to rise. These observations and late May ancillary observations are noted on Table IV-3.

b. Small Mammals and Avifauna

Inclement weather delayed the small mammal and avifauna sampling by one week and hindered the program several times. Traps were difficult to locate in the snow, and bait and nest material in the traps became wet.

Despite the cold spring, the tracts were in a state of transition from winter to spring during April. There was a noticeable increase in the numbers and diversity of fauna over February and as the sampling period progressed. Many migratory birds began to move onto the tracts; black-throated sparrows, rock wrens, and green-tailed towhee moved in numbers after the middle of April.

TABLE IV-3

REPTILE AND AMPHIBIAN OBSERVATIONS DURING APRIL 1975 SAMPLING PERIOD

	Vegetation Type			
	Greasewood	Juniper	Shadscale	Riparian
REPTILE				
Western Whiptail			X	X
Eastern Fence Lizard			X	X
Sagebrush Lizard			X	X
Side-blotched Lizard		X		
Garter Snake				X
Racer				X
AMPHIBIAN				
Lepoard frog				X

About 20 dead mountain bluebirds were found on the tracts, especially near the White River. They probably died of starvation during adverse weather. Most of the carcasses appeared to be fresh.

Rodent numbers were quite high for April, especially in the juniper and greasewood areas. There were indications that the rodent breeding season was beginning.

c. Large Mammal Monitoring Program

Deer numbers remained low throughout the study area until late April when domestic sheep were moved. At that time the deer began moving back into the area. The majority of observations were made in the riparian area along the White River. Observations indicate the deer stay either in the river bottom or on the nearby sagebrush benches to feed and ruminate. During the heat of the day the deer move away from these areas and into the canyons to rest in the shade of the cliffs. Numbers of deer have increased because of greater overall use of the study area; the majority of deer are still found near the White River.

The drug-capture program with the helicopter was successful. Only one animal was lost, which is considered normal. There was a wide variation in how the animals reacted to Succostrin. Larger doses produced more desirable effects than two smaller doses. Knowledge gained about animal reactions will be invaluable in working with additional animals during the course of the study.

Observations of raptors indicate that only a few golden eagles are actively nesting in the area. This is believed to be because of human disturbance and low numbers of prey species. The cliffs on the north side of the White River are the preferred nesting area for eagles although nests have been found throughout the study area. The entire study area was used by all species for hunting.

[illegible]

Waterfowl studies showed more paired Canada geese than expected. Four pair produced broods. Predation by raptors may have reduced nesting success of Canada geese.

3. TERRESTRIAL INVERTEBRATES

With the help of Dr. George Knowlton, Dr. Bohart ran samples through Berlese funnels, and the specimens were mounted or otherwise prepared for sending to specialists. The principal invertebrates collected were mites, centipedes, collembolens, several families of beetles, and a scattering of insect larvae.

Spring insect fauna samples were collected. Most of the insects collected were from Descurainia, Chorispora, and Erysimon (Cruciferae), from Cryptantha (Boraginaceae), from Astragalus (Leguminoseae), from Amelanchier (Rosaceae), and from Artemisia (Compositae). About 250 insects were mounted, adding about 80 species to the list compiled for the tracts.

4. AQUATIC BIOLOGY

Macroinvertebrate data since October 1974 are included in the Field Data Report. Many of the organisms are identified only to generic or familial level. In the case of some immature invertebrates, keys to specific level have not been developed or are unavailable. In the case of diatoms and other algae, specific identification is difficult and time consuming.

Macroinvertebrate density was lower in April 1975, but diversity was very near that of October 1974. The average number of organisms per Surber sample declined from 22.8 in October to 13.4 in April. (Because of ice cover, quantitative data are not available for the interim period.)

Qualitative changes were noted in the invertebrate fauna. Large stonefly nymphs were relatively abundant during February; *Brachyptera pacifica*, another stonefly, were also emerging. Most stoneflies recorded in April were *Arcynopteryx*. Normal seasonal changes observed included size increase in the mayfly nymphs as they near emergence date. *Traverella albertana* were common in October. The new annual crop of nymphs has not yet been detected.

Algal standing crop was low in April, probably because of low temperature and short day periods. Periphyton was qualitatively similar to past conditions.

5. MICROBIOLOGY

Analysis performed on the four soils types described in Section IV.A are listed in Table IV-4 for the sampling periods of March 28 and May 16, 1975. These two sampling periods represent the beginning of the soil microbiology program and therefore no correlative data summary can be drawn at this time. Future sampling periods scheduled in the summer and fall will better quantify any trends developing within the analysis of the soil microbiology program.

TABLE IV-4

SOIL MICROBIOLOGY ANALYSIS AND SAMPLING PERIODS

ANALYSIS	SAMPLING PERIOD	
	MARCH 28	MAY 16
pH	X	X
Moisture	X	X
Aerobic Bacteria	X	
Anoerobic Bacteria	X	
Streptomyces	X	
Fungi	X	
Proteinase Activity	X	
Dehydrogenase Activity	X	X
Chemical Analysis	X	X
Nitrification Analysis	X	
Nitrification Potential	X	
Repiration	X	X

C. WORK SCHEDULED

1. VEGETATION

The spring sampling of community structure and composition will be conducted the second and third weeks of June. Phenological and soil moisture and temperature data will be collected throughout the summer, as scheduled. Herbarium specimens will continue to be collected, prepared, and mounted as the organisms come into flower.

2. TERRESTRIAL VERTEBRATES

a. Reptiles and Amphibians

Terry Schulz (VTN) will be on the tracts from June 1 to approximately June 8 to quantify reptilian use of the four major vegetation plots. In addition, he will coordinate his activities with those of Jeff Grandison (DWR) to locate permanent pools which would be potential amphibian habitat and search the roads at night for snakes.

b. Small Mammals and Avifauna

The June and August bi-monthly sampling schedule will be conducted during the next quarter. The work will be as prescribed in the terrestrial sampling program except for the changes noted in this report (IV.A.2). The June sampling period will be the peak period for nesting birds. The August sample will include the first operation of the large rodent trapping grids. This procedure will assess the density of rodents on all primary sampling sites and will provide the necessary information to validate the trapping transects done on the other sampling sites. D. Balph, M. Balph, V. Grant, and P. Kung (USU) will be on the tracts during the June and August sampling periods.

c. Large Mammal Monitoring Program and Avifauna

With the initiation of the deer monitoring program and the completion of bobcat-coyote transmitters, a major portion of the upcoming quarter will be spent in the telemetry phase of the project. This will include regular monitoring of collared deer and trapping and monitoring of coyotes and bobcats. During June, the White River will be floated to determine nesting success of Canada geese and other waterfowl. Continued effort will be extended with assistance from Phil Wagner, Division of Wildlife Resources raptor biologist, in determining raptor nesting success on tract.

3. TERRESTRIAL INVERTEBRATES

Four trips are planned during the forthcoming quarter to collect quantitative samples of a representative series of species. These will consist primarily of routine sweep samples from the most prominent plant species. Further collecting in various habitats will be conducted. An insect cabinet on order will be used to reorganize the insect collection and additional determinations will be made in connection with the species list.

4. AQUATIC BIOLOGY

A field trip will be conducted for bimonthly sampling in June, 1975, as required by the lease agreement. High water conditions are expected to impair collecting efficiency at that time.

5. MICROBIOLOGY

Soil samples will be taken through the next quarter and analysis will continue as samples are collected and sent to the lab.

V. GEOLOGY AND SOILS

A. WORK COMPLETED

1. SOILS

Weather conditions during most of the quarter precluded fieldwork for the soils portion of the baseline study.

VTN staff and Utah State University (USU) soil scientists met April 16 and 17 in Logan to clarify the details of work remaining in the soils program.

During the week of May 12, VTN staff and USU soil scientists met in the field to review the soil survey results obtained to date, to assess the work remaining, and to study the perimeter area. Some soils mapping was continued, and several profiles were sampled and described.

2. GEOLOGY

During the last three months, VTN geologists have collected and interpreted sufficient data to complete a detailed description of the geology in the region of the White River Shale Project. Geological aspects of the regional area investigated for the report include physiography, geologic history, stratigraphy, geologic structure, geologic hazards, and mineral resources. A literature search was conducted and supplemental data were gathered that enlarged the area covered by previous on-site exploration to include the entire Uinta Basin, with emphasis on the geology in the vicinity of the site. After completion of the regional geology report, the geology and ground water system within Evacuation Creek Canyon was investigated. (See Ground Water section).

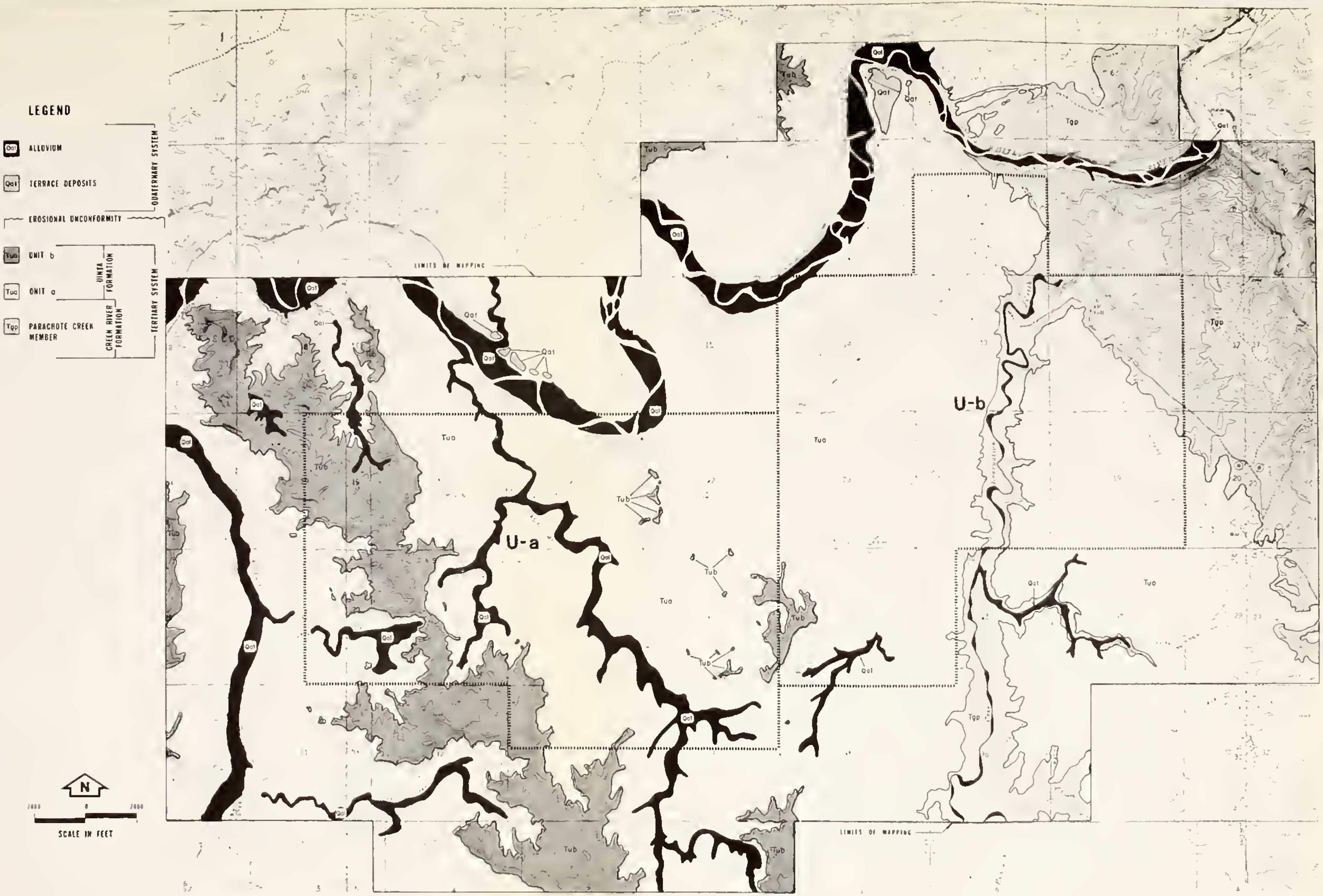
B. DATA SUMMARY

1. SOILS

Detailed analyses of soil texture, infiltration plots, and soil chemistry were completed and are being used in correlating mappable soil units. Soil description using 64 cores has enabled USU and VTN staff to prepare preliminary soil maps for Southam Canyon, the proposed dam site, and the proposed retort facility. There are approximately 20 separate representative mappable soil units characterized by their relationship to slope, basin aspect, parent material, vegetation, and microclimatic conditions. The soil descriptions, core location, and vegetative relationships are described in detail in the Field Data Report.

2. GEOLOGY

Various geologic field data from on-site exploration last quarter were finalized. Figure V-1 is a geologic map of the gently dipping rock formations exposed at the surface around the site. The map was prepared in the field using color and black and white aerial photographs in stereo-pairs to provide accurate positioning on the ground. Plotting the actual forma-



vtn

GEOLOGIC MAP OF OIL-SHALE TRACTS U-a & U-b , UINTA COUNTY, UTAH

FIGURE V-1

tion contacts on the maps involved extensive on-the-spot interpretation.

Subsurface information concerning rock strata occurrence, extent, and thickness is provided by geophysical logs compiled for all existing oil and gas test wells within 5 miles of the site boundary. Table II-5 is a descriptive tabulation of all the logs. (See Ground Water section.) Interpretations of these logs formed the basis for constructing a geologic cross-section (Figure V-2) which shows the depth, thickness, and geometrical relationship between the mining zone, rock formations, and primary aquifer in the vicinity of the site.

The oldest rock strata exposed at the surface on the tract lie within the upper Parachute Creek Member of the Green River Formation (shown as Tgp on the map). Forty to 60 million years ago (Eocene epoch), calcium carbonate mud, rich in microscopic organisms, accumulated on the bottom of ancient Lake Uinta and on subsequent burial and compaction became the marlstone and oil shale deposits of the Green River Formation. Rich oil shale deposits are not exposed at ground surface within the tracts, but lie in the subsurface, as shown on Figure V-2; the mahogany marker occurs just above the richest oil shale zone. Only about 300 feet of upper Green River Formation beds crop out on site. The total thickness of the Green River Formation is roughly 1,400 feet in the subsurface below the site. Outcrops consist of mostly light-to-dark-gray, thinly bedded, extremely hard, brittle, calcareous marlstone overlying a

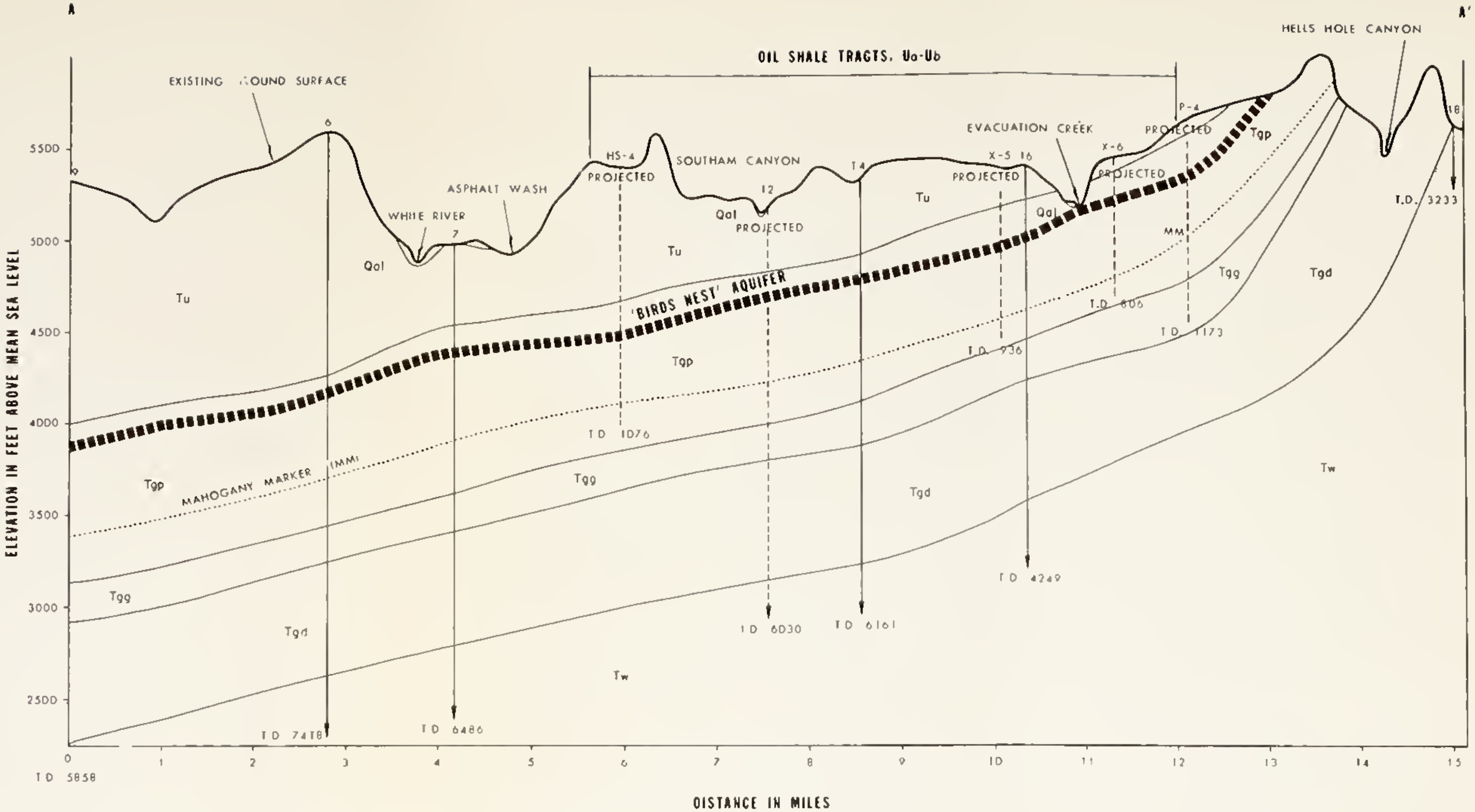
LEGEND

QUATERNARY

Qal	ALLUVIUM	

TERTIARY

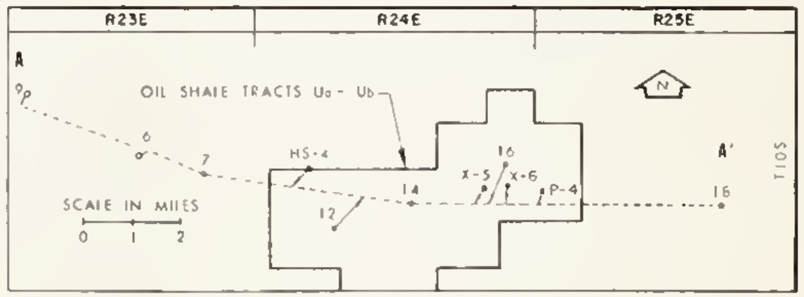
Tu	UINTA FORMATION	
Tgp	PARACHUTE CREEK MEMBER	GREEN RIVER FORMATION
Tgg	GARDEN GULCH MEMBER	
Tgd	DOUGLAS CREEK MEMBER	
Tw	WASATCH FORMATION	
X-5 •	CORE HOLES, WITH PROJECT NO. DESIGNATION	
•16	OIL AND GAS TEST WELLS WITH GEOPHYSICAL LOGS	



OIL AND GAS TEST WELLS WITH GEOPHYSICAL LOGS

MAP NO.	OPERATOR	DESCRIPTION
9	BELCO	TEXOTA #1
6	EL PASO N.G. CO.	SOUTHAM CANYON #3
7	SHELL OIL	SOUTHAM CANYON #7
12	EL PASO N.G. CO.	SOUTHAM CANYON #4
14	MOAB DR. CO.	GEM #1
16	CONTINENTAL OIL CO.	#1 AA 120 WATSON
18	OIL INC.	BONANZA #2

LOCATION OF CROSS-SECTION



NOTE : T.D. IS TOTAL DEPTH OF BORE HOLE IN FEET

REGIONAL GEOLOGIC CROSS-SECTION

THROUGH OIL SHALE TRACTS Ua-Ub

FIGURE V-2

prominent bed of up to 20 feet thick made up of brown fine-grained sandstone. Underneath are strata of fractured siltstone called the "bird's nest zone" because of its characteristic appearance created by numerous elongate cavities, usually less than 2 feet in diameter, with rough, prickly inside surfaces. These cavities were formed by solution of pods and lenses of nahcolite (sodium bicarbonate) (Cashion, 1971). Minor amounts of this salt still remain within the strata. The brown sandstone and fractured siltstone-containing cavities represent an important aquifer system; a detailed discussion of this is included in the Ground Water section.

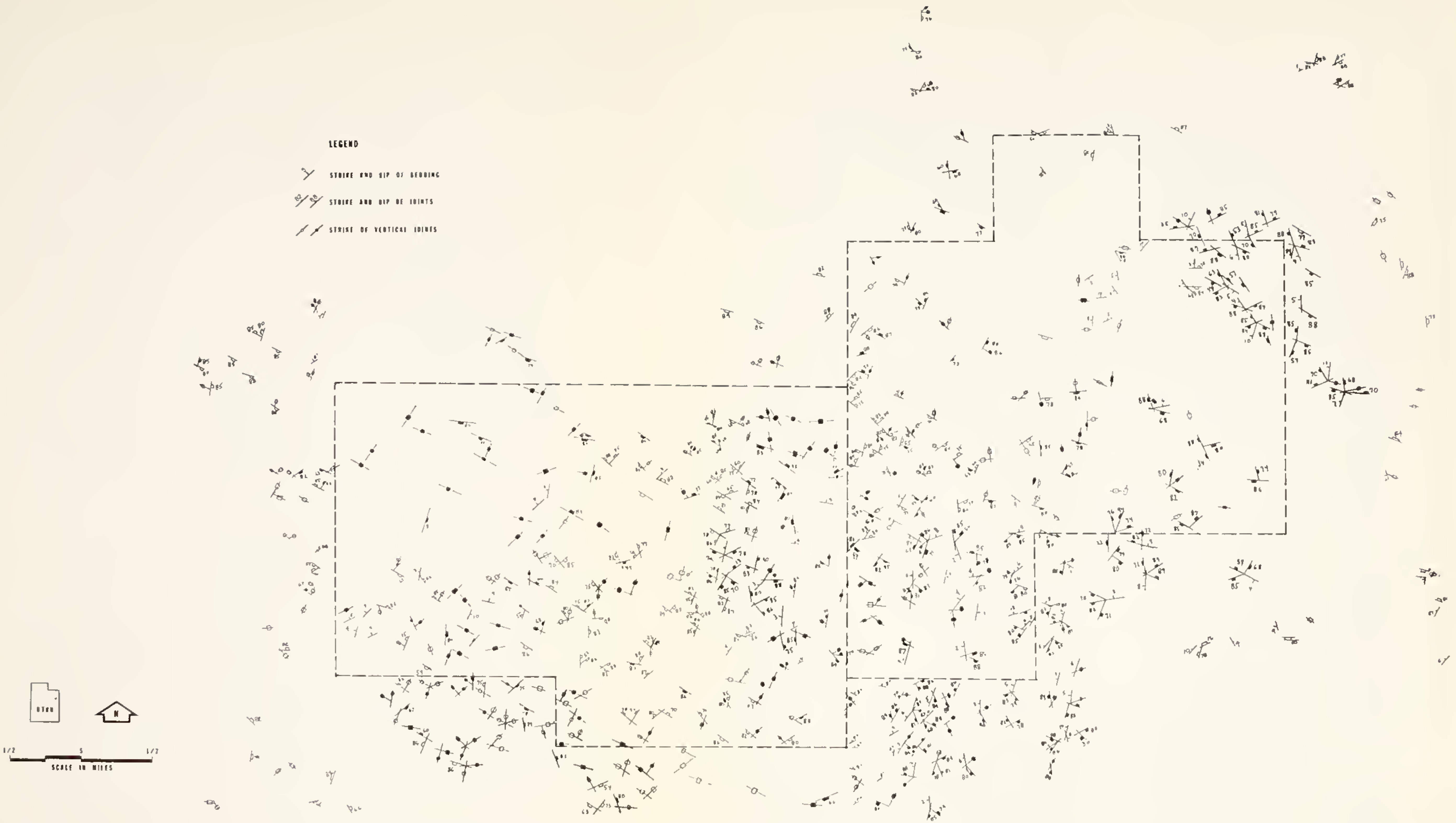
Regional uplift during the late Eocene caused Lake Uinta to begin drying up and dwindling in size. This lead to an accompanying change in the mode of sedimentation and deposition of rock strata above the Green River Formation. Large river systems developed with channels meandering back and forth across the ancient lake basin and depositing primarily sand. These deposits comprise the Uinta Formation sandstone, also Eocene in age, shown as Tua and Tub on the map.

Lithologically, both Unit a and Unit b of the Uinta Formation are very similar: both are of yellowish gray fine-to-medium-grained sandstone interbedded with minor amounts of gray to greenish gray siltstone and marlstone. Unit a is about 740 feet thick. Only the lower 600 feet of Unit b is exposed on site. Separation of the two units for geologic mapping was based on a prominent marker bed of volcanic tuff or tuffaceous sandstone that weathers yellowish orange and typically caps topographic benches and buttes. Unit b occurs stratigraphically above Unit a with their plane of contact defined as the base of the marker bed.

Since the close of the Eocene, there has been a long period of subaerial exposure and subsequent erosion of the Uinta Formation. This situation still exists in the majority of the site region; however, along the White River, there are remnants of river terraces of Holocene and Pleistocene Age deposited as much as one million years ago consisting of slightly-cemented cobbles and pebbles of gray to tan quartzite and chert in a matrix of fine sand. The youngest deposits lie within and along Evacuation Creek, Southam Canyon, and the White River.

Geologic structures at the proposed mine site in the vicinity of the tracts are shown on Figure V-3. This map was prepared by geologists mapping the extent of rock formations. Measurements recorded on the map were taken by extensive field traverses on foot with a Brunton compass. Each strike and dip symbol represents the orientation of a planar surface at the point where the geologist stood to take measurements in the field.

Geologic structure at the site is simple. The strata generally dip less than 5 degrees (below horizontal) toward the north or northwest and have no known faults. Minor folds are present only in the lower part of the Uinta Formation as a



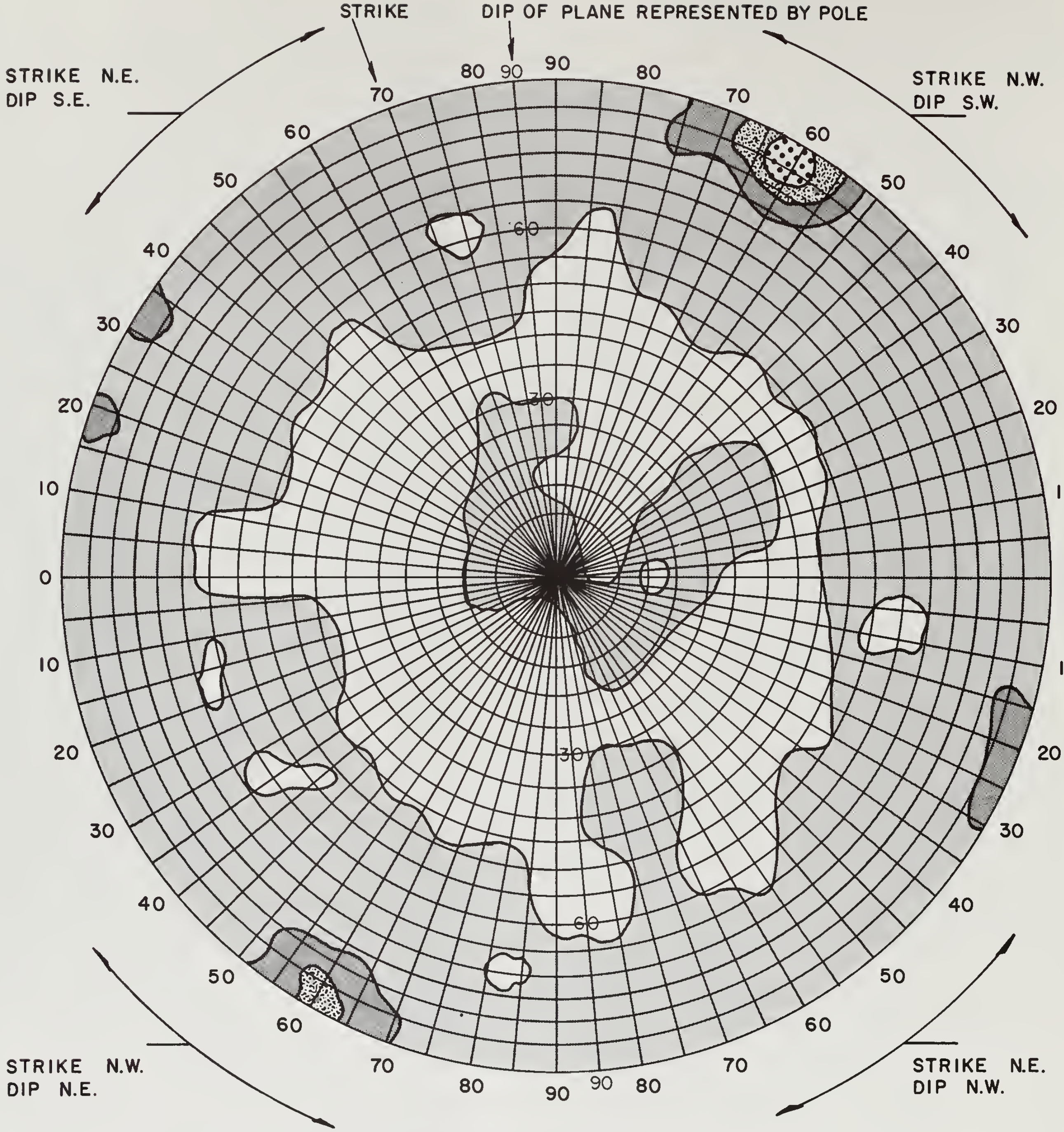
STRUCTURAL GEOLOGIC MAP OF OIL-SHALE TRACTS U-a & U-b , UINTAH COUNTY, UTAH

FIGURE V-3

result of soft-sediment deformation. The folds are so small that mapping is not practicable. Remarkable sets of near-vertical joints (rock fractures) occur throughout the site area.

Since the joints are very important in the overall strength and stability of the strata, they were mapped and analyzed in detail. In this process each mapped joint orientation was plotted as a point (pole) on a circular grid according to its strike and dip (see Figures V-4 through V-7). Then, based on the density of poles falling within different areas of the grid, a percent contour diagram was constructed. These diagrams show concisely the joint set orientations, which are of primary, secondary, and tertiary importance in the mine area. Figure V-4 includes all of Tracts U-a and U-b, Figure V-5 includes the area to the northeast of Tract U-b, Figure V-6 includes the southwest portion of Tract U-b, and Figure V-7 includes the area south of Tract U-a.

Considering all joints mapped within the entire site area, the primary set trends north 22 degrees east and dips 88 degrees toward the northwest. Three secondary sets are also present. Their trends are north 22 degrees east, north 18 degrees east, and north 33 degrees east. These sets dip 88 degrees northwest, 88 degrees southeast, and 87 degrees southeast, respectively. Although veins of gilsonite (a black asphaltite) trend northwest along the primary set of joints that occur throughout the e eastern Uinta Basin, no veins are exposed at the ground surface



PURPOSE

ANALYSES OF PRINCIPLE JOINT SYSTEMS

AVERAGES

PRIMARY SET ... N62W/86SW

SECONDARY SETS ... N22E/88NW
N18E/88SE
N33E/87SE

LEGEND

CONTOUR INTERVAL IN PERCENT OF TOTAL SAMPLE

░ 0-5

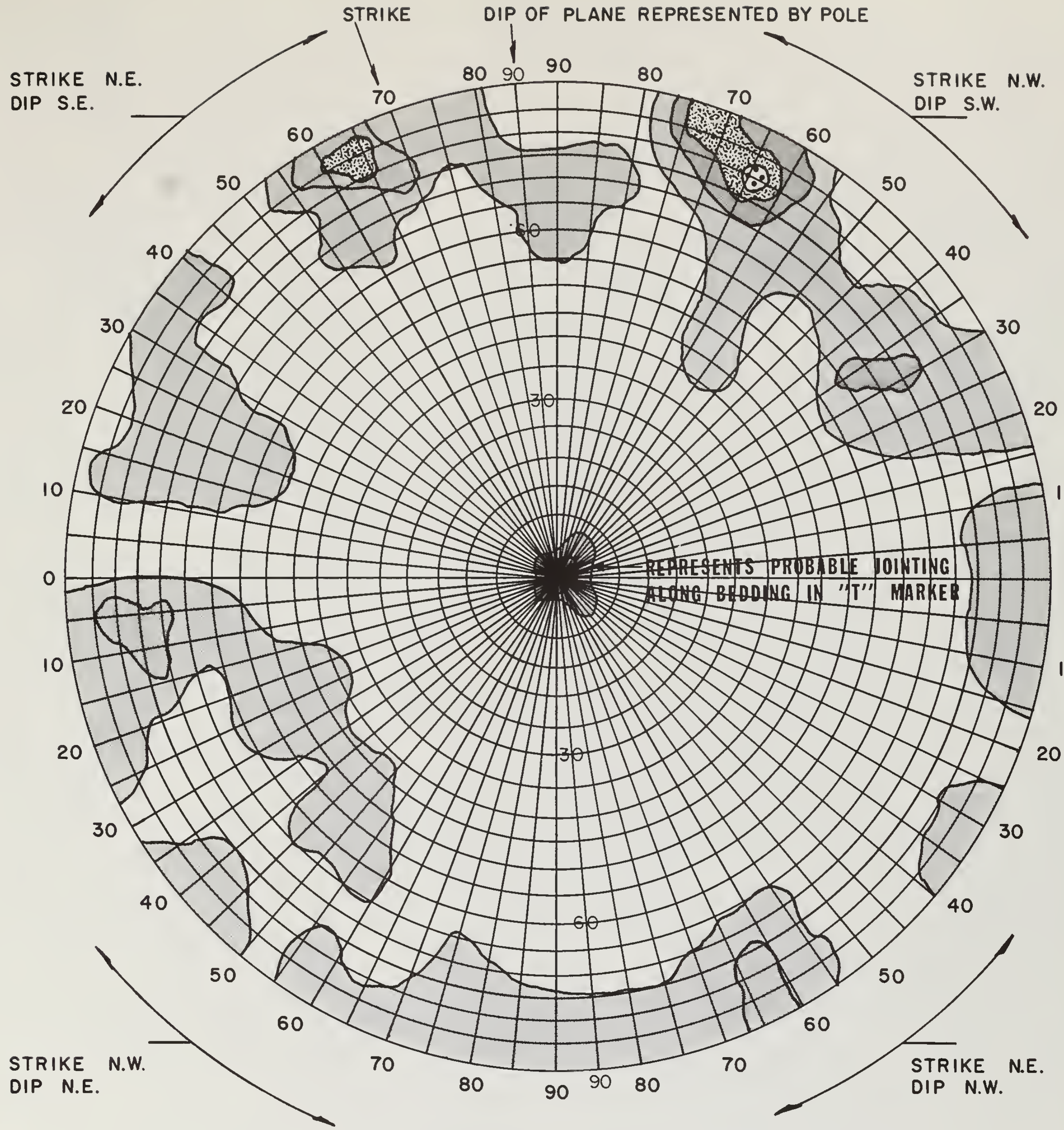
▒ 5-10

▨ 10-15

⁘ 15-20

COUNT DIAGRAM OF POINTS REPRESENTING JOINT ORIENTATIONS, TRACTS U-a & U-b

FIGURE V-4



PURPOSE

ANALYSES OF PRINCIPLE JOINT SYSTEMS

AVERAGES

PRIMARY SET ... N69W/80SW
N63E/81SE

SECONDARY SETS ... N63E/83NW
N33W/66SW
N8W/75NE

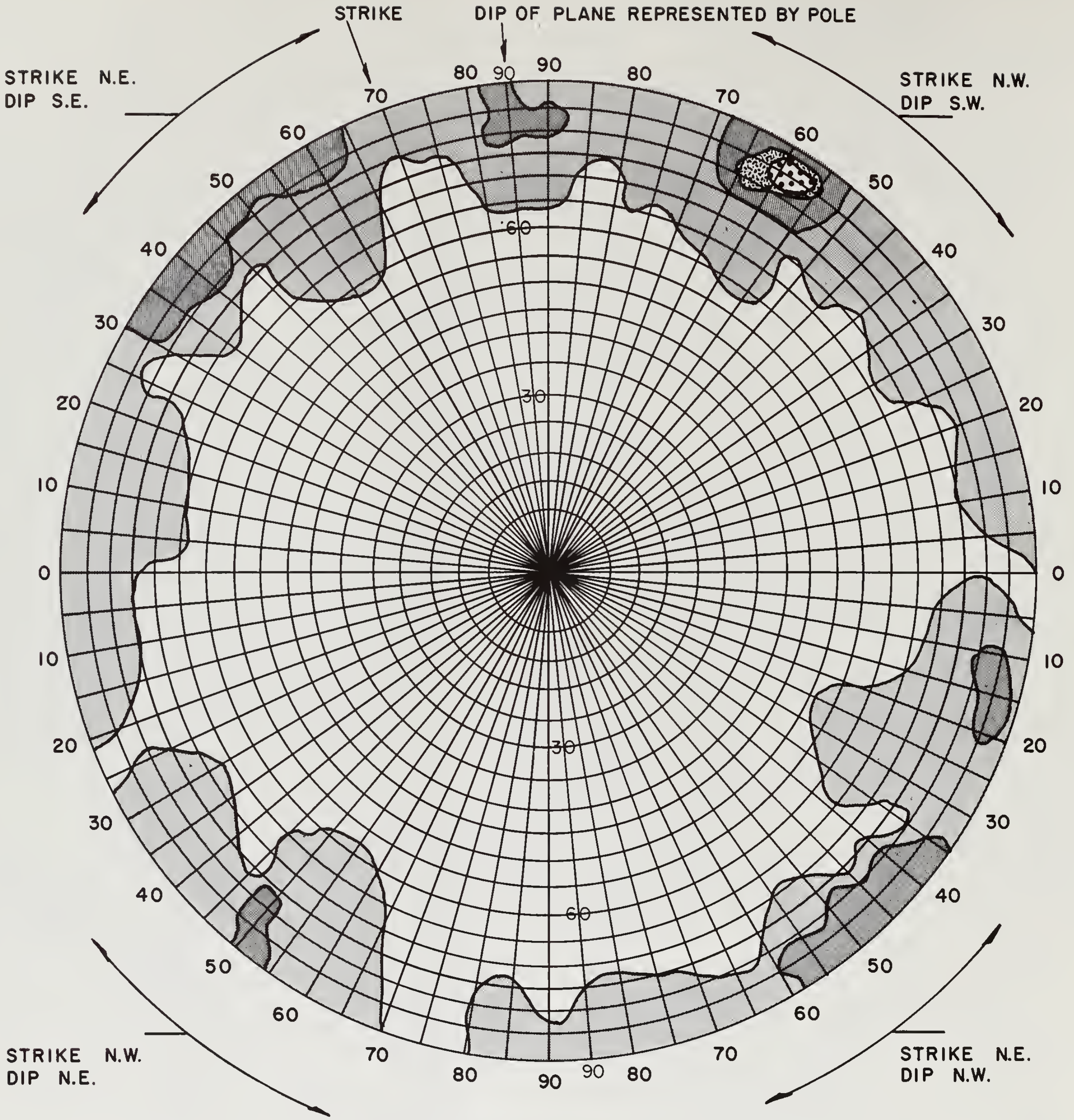
LEGEND

CONTOUR INTERVAL IN PERCENT OF TOTAL SAMPLE

░ 0-5
▒ 5-10
▓ 10-15
⁘ 15-20

COUNT DIAGRAM OF POINTS REPRESENTING JOINT PLANE ORIENTATIONS, SEC. 7,8,17,18, T10S, R24E

FIGURE V-5



PURPOSE

ANALYSES OF PRINCIPLE JOINT SYSTEMS

AVERAGES

PRIMARY SET ... N57W/84SW

SECONDARY SET ... N59E/86SE
N46E/89NW

TERTIARY SET ... N85E/83SE
N17E/85NW
N51W/86NE

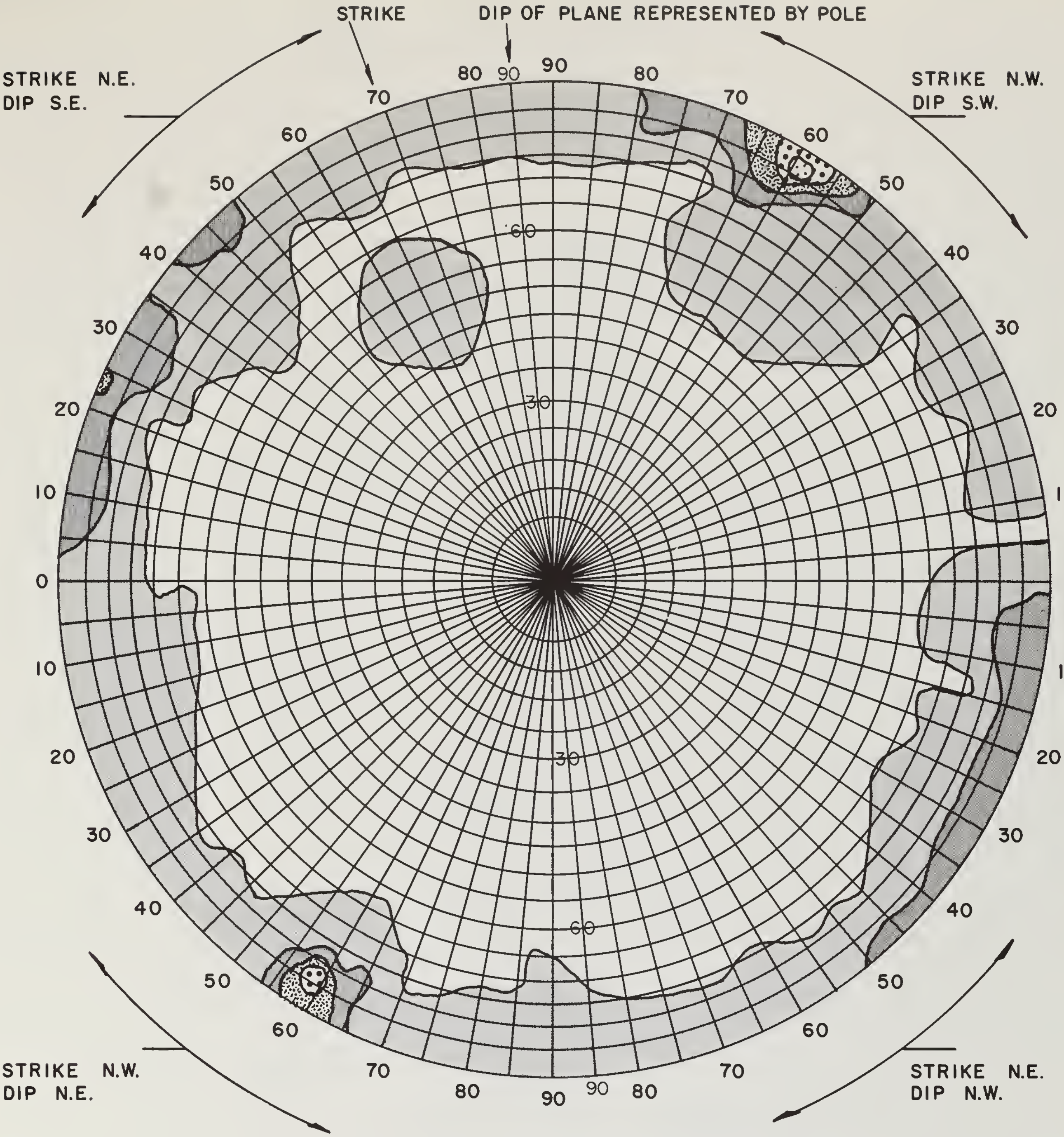
LEGEND

CONTOUR INTERVAL IN PERCENT OF TOTAL SAMPLE

░	0-5
▒	5-10
▓	10-15
⁘	15-20

COUNT DIAGRAM OF POINTS REPRESENTING JOINT PLANE ORIENTATIONS, SEC. 23, 24 & 26, T10S, R25E

FIGURE V-6



PURPOSE

ANALYSES OF PRINCIPLE JOINT SYSTEMS

AVERAGES

PRIMARY SET ... N59W/86SW
N58W/84NE

SECONDARY SET ... N24E/89SE
N24E/89NW

TERTIARY SET ... N45E/88SE

LEGEND

CONTOUR INTERVAL IN PERCENT OF TOTAL SAMPLE

░ 0-5
▒ 5-10
▓ 10-15
⁘ 15-20
∴ 20-25

COUNT DIAGRAM OF POINTS REPRESENTING JOINT PLANE ORIENTATIONS, SEC. 31,32 & 33, T10S, R24E

FIGURE V-7

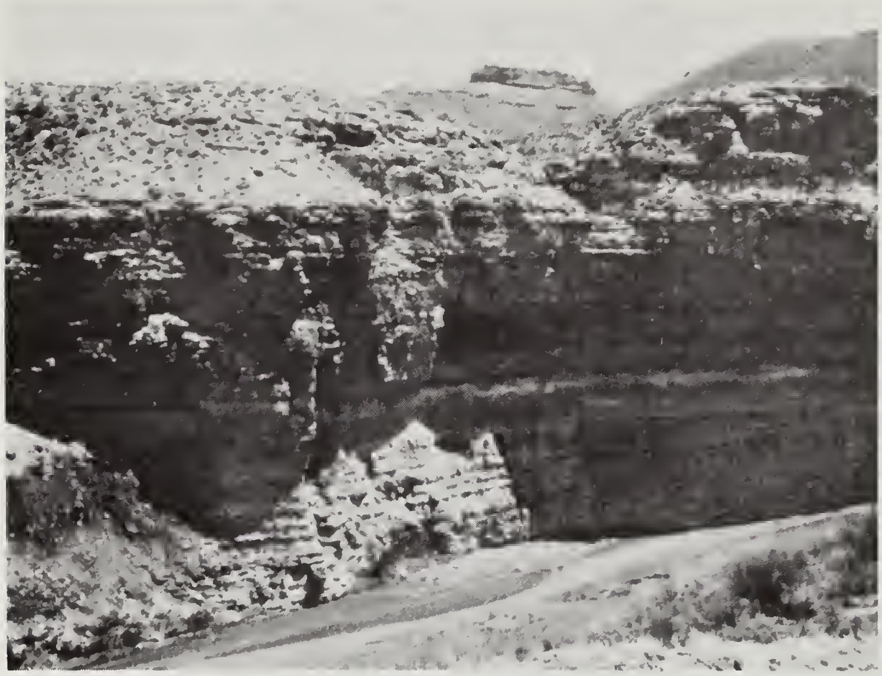
within the oil shale tracts. At the site the joints are generally open and have smooth inside surfaces. It is reasonable to assume that a similar set of joints occurs within the mining zone. Projections of this information down into the subsurface mining zone, using exploratory corehole information for control, will provide the basis for geologic interpretations essential to evaluation of underground stability of the proposed mine.

The hydrogeologic investigation of Evacuation Creek Canyon indicates that within the tracts an aquifer of primary concern, the bird's nest aquifer, is exposed at the ground surface throughout Evacuation Creek Canyon. Furthermore, the system of drainage tributaries leading across those aquifer outcrops overlie an important ground water recharge area. (Figure V-8 depicts the aquifer outcrop.) Aquifer outcrop areas delineated and mapped in the field are shown on Figure II-7; this map also shows measurements of specific conductance used to distinguish ground water seeps and springs from water flowing over the surface and down through Evacuation Creek. (See Ground Water section.)

C. WORK SCHEDULED

1. SOILS

Field mapping of Tracts U-a and U-b (proper) is near completion. A one-mile buffer zone surrounding the tracts is under study with completion tentatively scheduled for the last quarter of 1975.



BIRDS NEST AQUIFER NORTH OF S-2 ON EVACUATION CREEK

PHOTOGRAPH OF BIRDS NEST AQUIFER

EVACUATION CREEK

FIGURE V-8

2. GEOLOGY

Data from the geologic exploration boreholes and ground water investigations borings will be condensed and compiled into a concise form next quarter so that this information may be used for the on-site geologic report and for future reference.

VI. HISTORIC AND SCIENTIFIC RESOURCES

A. WORK COMPLETED

The cultural (historical and archaeological) and paleontological resource investigations were completed during this quarterly period, and the subconsultants are preparing reports on these investigations. A report on the regional cultural and paleontological resources was also prepared during this period.

B. DATA SUMMARY

The cultural resources identified to date represent only a few cultural periods. For prehistoric periods, projectile points of the late Archaic (5,000 to 2,500 BP) and Fremont (1,500 to 500 BP) were found. These may not be representative of all the possible cultural periods since many of the sites have been disturbed by artifact collectors. Subsurface investigations may be necessary to locate diagnostic artifacts of other cultural periods to provide a more complete culture history of the tracts. Historical resources identified by the investigations include homestead cabins, the Ignacio Stage Station, and the toll road which led from Dragon to Vernal during operation of the Uinta Railway.

The paleontological resources identified to date consist of numerous flora and fauna fossil specimens. The fossils include leaves, wood, insects, fish, turtles, crocodiles and brontotheres found in the Green River and Uinta Formations. These types of flora and fauna occurred during early Tertiary Period, Eocene Epoch (approximately 40 - 60 million years ago). During the Eocene, the environment of the Uinta Basin changed from lacustrine (lake) to riverine. Generally, the Eocene was warm and humid. Table VI-1 lists the types of fossils and the geological formations in which they are found.

TABLE VI-1

FOSSIL SPECIMENS LOCATED ON TRACTS U-a AND U-b

	Fossil	
Formation	Flora	Fauna
Uinta	petrified wood (unidentified)	turtle crocodile brontothere
Green River	algae reeds laurel willow poplar sycamore petrified wood (unidentified)	insects, various (adult and larval forms) fish (gar pike, and other unidentified)

C. WORK SCHEDULED

Preliminary reports are being prepared by the cultural and paleontological resource subconsultants. These will be reviewed by VTN personnel and returned to the subconsultants for preparation of their final reports, due on July 31, 1975. A more detailed description of the cultural and paleontological resources will be presented in the fourth quarterly report.

VII. REVEGETATION STUDIES

A. WORK COMPLETED

In late April, a series of four revegetation plots were established in areas disturbed by test-hole drilling. Nearly 1,000 plants of six native shrub species were transplanted April 24 and 25 on four drill sites. These plantings were visited in May at three different times to check their condition. During these visits selected plantings were irrigated for experimental purposes.

B. DATA SUMMARY

No quantitative data have been collected on the success of these plantings at this time (May 31). Estimates to complete the rehabilitation program as described in the Fish and Wildlife Management Plan are listed for each program element in Table VII-1.

C. WORK SCHEDULED

In the next quarter a final report on the past six months work will be prepared. This report will represent the completion of the initial phase of the revegetation studies.

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C. WORK SCHEDULED

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TABLE VII-1

POTENTIAL SURFACE DISTURBANCE FROM MONITORING ACTIVITIES

	Area Disturbed (Sq. Meters)	Area To Be Rehabilitated (Sq. Meters)	Time to Recover (Years)	Estimated Net Loss (Sq. Meters)
Aerometric Monitoring Sites (12)	6400	6400	2-11	400
Core Hole Sites (10)	27900	27900	5-10	1200
Groundwater Monitoring Sites (21)	20400	19900	1-10	1600
Pilot Test Sites (4)	39000	39000	5-8	Unknown
Surface Water Monitoring Sites (14)	3100	3100	2-8	100

SOURCE: Fish and Wildlife Management Plan VTN

VIII. GEOLOGIC EXPLORATION PLAN

A. WORK COMPLETED

The laboratory work required for the oil shale assay, mineralogic, and rock testing programs has been or soon will be completed. The mining group is using these data as part of their investigation of the mining zone.

A preliminary report has been written which summarizes the data acquired from all drilling programs in the form of lithology structural features and shale oil content.

B. DATA SUMMARY

The four pilot test holes drilled for the ground water exploration program, the nine geological exploration holes, and the seven nomination holes make a total of 20 holes available for a subsurface data grid on approximately one-mile spacing throughout the area encompassed by the two tracts. In all, about 7,200 feet of the available 9,100 feet of core was used for 6,200 modified Fischer assays.

Table VIII-1 is a summary of cored footage and recovery from the 20 holes cored. Recovery was in all cases over 90 percent.

Selected drill holes were chosen to present the mineralogic data. These data are given in Table VIII-2.

Complete assays and mineralogic determinations of the cores are being tabulated and analyzed.

TABLE VIII-1

EXPLORATION DRILL HOLES
CORE RECOVERY

Hole #	TD	Cored Increment	Feet Cored	Core Recovered	Core Lost	% Recovery
Evacuation #1	899	465- 899	434	426.1	7.9	98.2
Evacuation #2	749	350- 749	399	397.8	1.2	99.6
Evacuation #3	940	433- 940	507	486.9	20.1	96.0
Southam #1	1,141	817-1,141	324	323.4	0.6	99.8
Southam #2	964	821- 964	143	134.5	8.5	94.1
Southam #3	1,130	961-1,130	169	168.7	0.3	99.8
Southam #4	1,037	910-1,037	127	126.9	0.1	99.9
P- 1	1,238	64-1,238	1,174	1,162.0	12.0	99.0
P- 2	1,290	94-1,290	1,196	1,137.6	58.4	95.1
P- 3	1,220	70-1,220	1,150	1,333.2	16.8	98.5
P- 4	1,176	52-1,176	1,124	1,112.8	11.2	99.0
X- 1	1,140	870-1,140	270	268.8	1.2	99.6
X- 2	766	460- 766	306	292.6	13.4	95.6
X- 3	591	321- 591	270	269.7	0.3	99.9
X- 4	958	660- 958	298	272.6	25.4	91.5
X- 5	936	670- 936	266	263.8	2.2	99.2
X- 6	806	510- 806	296	295.0	1.0	99.7
X- 9	1,068	816-1,068	252	249.1	2.9	98.8
X-10	1,093	840-1,093	253	252.5	0.5	99.8
X-11	1,023	690-1,023	333	324.7	8.3	97.5
TOTALS	20,165		9,291	9,098.7	192.3	97.9 (Ave.)

TABLE VIII-2

MINERALOGY OF OIL SHALE FROM TRACTS U-a AND U-b

Sample Location	Calcite-% $CaCo_3$	Dolomite-% $(CaMg) CO_3$	Analcime-% $NaAlSi_2O_6$ H_2O	Feldspar-%	Quartz-% SiO_2	Vanadium (PPM)	Nickel (PPM)	Arsenic (PPM)	Lead (PPM)
Hole X-9	14	36	-	16	34	339	46	61	20
Hole X-3	27	27	-	21	25	248	17	11	16
Hole X-1	17	34	-	34	15	248	29	34	18
Average	19	32	-	24	25	278	31	35	18
Colorado Oil Shale	12	24	10	33	21	698	18	6	18

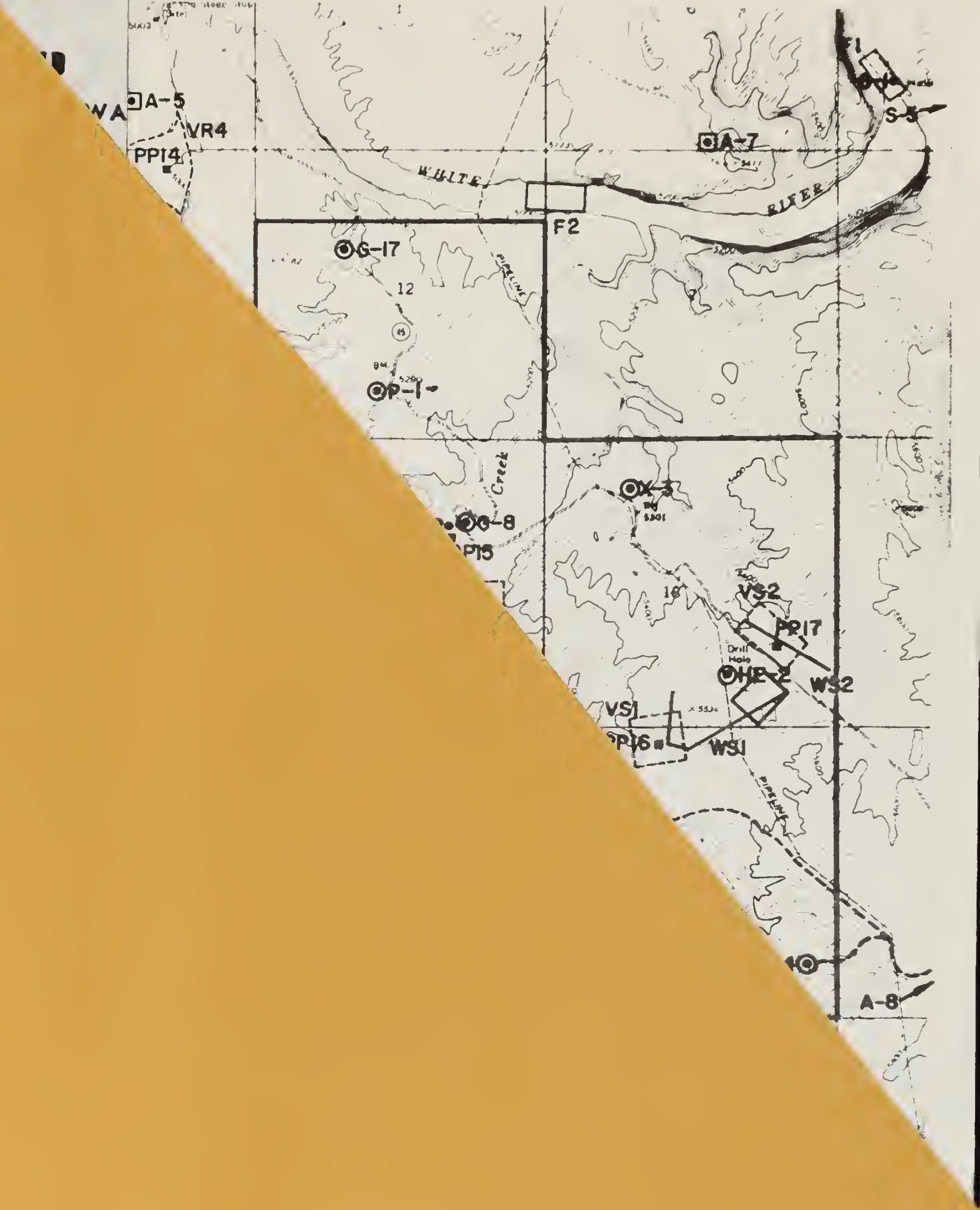
Note: Analysis as reported by Colorado School of Mines Research Institute - 6 June 75

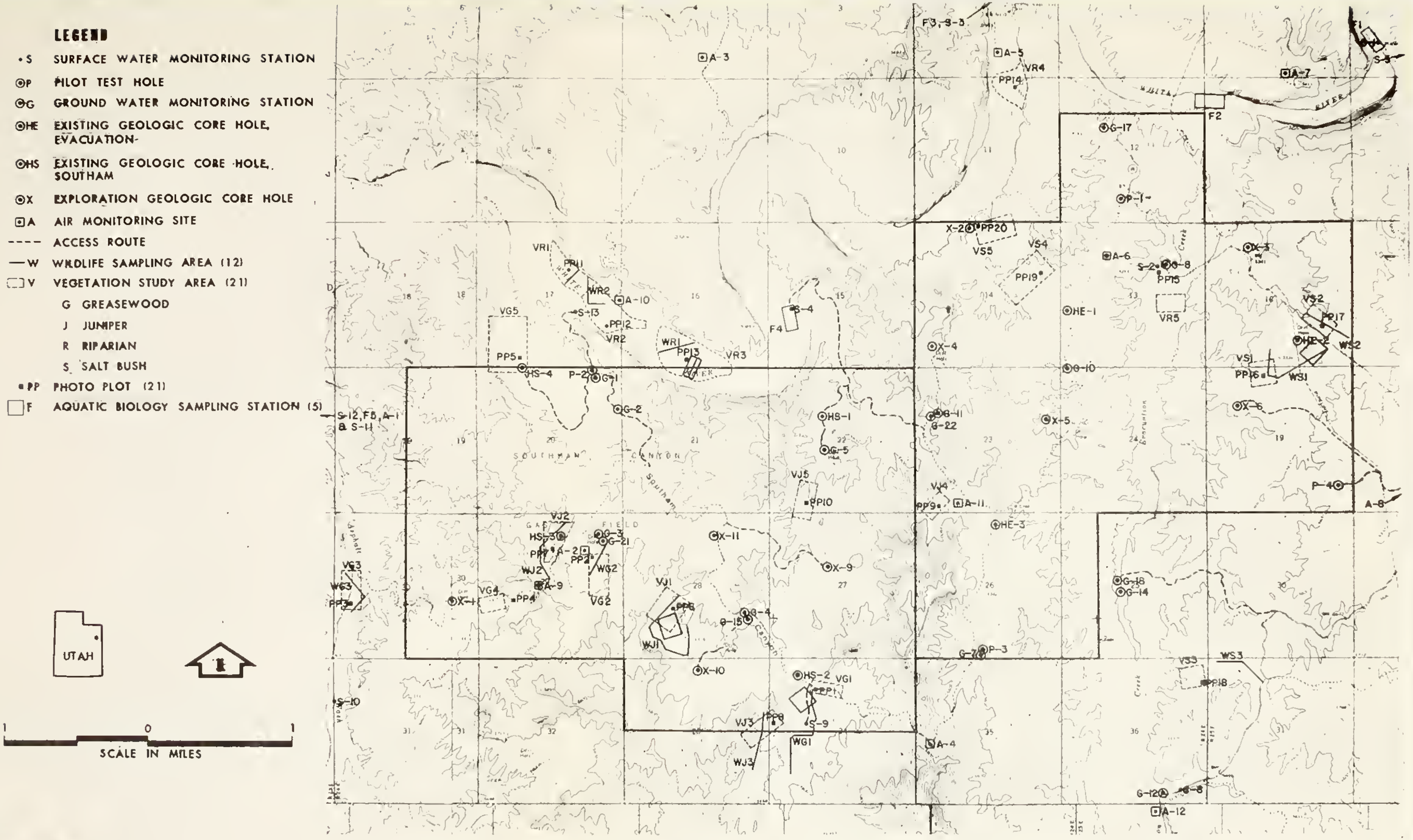
PWM/cs

The mahogany zone, as defined from assays and cores, is an arbitrary unit that includes the highest proportion of oil to shale in the Parachute Creek Member of the Green River Formation. The thickness of the zone averages 100 feet and varies from 97 to 111 feet in the drill holes on the tracts.

C. WORK SCHEDULED

The rock mechanics and mineralogic testing portion is scheduled for completion next quarter. These data will be integrated with the assay data and recoverable alumina test data into the description of the mining zone. These testing programs are nearly complete and may be available for the next quarterly reporting period.


WA
A-5
VR4
PP14
A-7
F1
S-5
WHITE
RIVER
F2
G-17
12
PIPELINE
P-1
Creek
X-3
G-8
PP15
16
VS2
PP17
Drill Hole
HE-2
WS2
VS1
PP16
WS1
PIPELINE
A-8



WHITE RIVER SHALE PROJECT

FIELD MONITORING SITES

EASTERN UINTA BASIN, UTAH

Form 1279–3
(June 1984)

BORROWE

TN 859 .U82 W418 no.

Quarterly report:
Environmental Base

DATE LOANED	BORROWER

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